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# PRINCIPLES

OF

# HUMAN GEOGRAPHY

BY

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*SECOND EDITION, REVISED*
TOTAL ISSUE, TWENTY-EIGHT THOUSAND



NEW YORK
JOHN WILEY & SONS, INC.
LONDON: CHAPMAN & HALL, LIMITED
1922

6/23

Press of
Braunworth & Co.
Book Manufacturers
Brooklyn, N. Y.

# PREFACE

The purpose of this book is, first, to set forth the great principles of geography in its human aspects; second, to provide a comprehensive, but easily taught text book for students who have reached an age when they begin to think for themselves; and, third, to furnish to normal school students and to teachers in elementary schools a book which will give them a solid grounding in the human relationships which they are eager to teach. Many books have been written on "anthropogeography," but there seems to be great need of a book which sums up the present status of that subject and at the same time translates it into the simpler terminology of "human geography."

The method of the book is to take up first the physical background, not dwelling on it technically, but merely sketching the main outlines, and providing an adequate basis if the teacher wishes to go farther. In case of such relatively simple matters as water bodies, little or no physiographic treatment is deemed necessary, for such details as the difference between a meandering and braided river have little effect on man's activities. The fundamental principles of climate, on the other hand, have been quite fully treated because of their supreme importance in determining man's mode of life. Nevertheless, pure meteorology receives less attention than in most of the physiographic text books which are now the main reliance in teaching advanced geography.

After the physical background has been sketched each chapter or part of the book plunges directly into the main theme, that is, the relation of the physiographic environment to man's activities. This is the part of geography which is most interesting, most practical, and most calculated to call forth genuine thought and concentrated effort on the part of the student. It is also the part which in most books is more or less incidental or secondary, whereas it is here the primary object.

The chief points in which this book differs from other books of geography are, first, its concentration on human relationships; second, its emphasis on the *effects* of climate rather than upon the physical and meteorological sides of the subject; third, its inclusion of chapters on Vegetation and Diet, two subjects whose geographical significance has been largely overlooked; and fourth, its interpretation of political geography. This last part of the subject does not mean the study of political divisions, but of the political relationships, both domestic and foreign, which arise out of geographic conditions.

Finally the present volume departs from its predecessors by adding genuine problems to the mere questions which are ordinarily found at the end of chapters. In actual practice it has been found that students take hold of the problems with great eagerness and energy.

So many teachers and others have given suggestions of great value in regard to various chapters that it is impossible for the authors to do more than express their deep gratitude to all who have assisted. Special mention should be made, however, of Miss Mary E. Sanders, formerly of Cheltenham College, England, who has assisted in preparing the exercises.

## NOTE TO SECOND EDITION

In the revised edition of this book large parts of Chapter II have been rewritten as have certain sections of Chapters IV, VII, X, and XIII. Minor alterations have been made in many other chapters and new problems have in some cases been added. The following persons have helped materially in the revision by critical reading of the entire book or of parts of it dealing with their specialties. Their kindness is gratefully acknowledged: G. G. Chisholm, Professor of Geography, University of Edinburgh; William Morris Davis, Professor of Geography, Harvard University; Roland M. Harper, Alabama Geological Survey; W. J. Humphreys, Professor of Meteorological Physics, United States Weather Bureau; Adolph Knopf, Associate Professor of Petrology, Yale University; D. H. Markham, Professor of Geography, University of Arkansas; H. A. Marmer, U. S. Coast and Geodetic Survey; Stephen S. Visher, Assistant Professor of Geography, Indiana University, and A. E. Waller, Professor of Botany, Ohio State University.

The revision has also been facilitated through reviews by Dr. C. E. P. Brooks, Royal Meteorological Society; Professor R. D. Calkins, State Normal School, Mt. Pleasant, Michigan; the Bulletin of the Imperial Institute of the United Kingdom, the Colonies, and India; and especially Professor Harlan H. Barrows of the University of Chicago.

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# NOTE TO THE TEACHER

## Questions, Exercises and Problems

In order that the Principles of Human Geography may be effectively taught, full use should be made of the questions, exercises and problems that follow each chapter. These vary considerably in difficulty and in subject matter, some being physiographic, some economic, or historical, and many purely anthropogeographic. Thus they are adapted to students of different grades of ability and of different interests. For younger classes, such as those of the high school, only the simplest problems need be used, while the more complex problems will tax the powers of the most brilliant college student. Many of the problems, however, are elastic. They may be solved briefly and in a general way by young and relatively backward students, but need much time and thought in the hands of capable and advanced students. Again, a large number of the problems are suited to many regions in addition to the ones mentioned in the text. In all cases, however, stress should be laid on the students' own homes. The principles discussed in the text, as well as in the problems, should be applied first of all to the local region, which should serve as a starting point for an understanding of the remoter parts of the world.

Often it will be wise to assign the same problem to the whole class, but let each student take a different region. The more complex problems can sometimes be best solved by letting each student make an exhaustive study of one special phase and then uniting the results in a classroom exercise. Throughout the problems great stress should be laid on (1) accurate statistics as opposed to loose generalizations; and (2) map-making in contrast to mere statements in words. Wherever possible, written statements should be supplemented by accurate diagrams and maps. In using the problems and exercises do not be in too much haste to give your students your own matured conclusions. *Show where to find the facts and how to use them, and let the students reason for themselves.*

### Books for General Reference

The Principles of Human Geography can be effectively taught with a small equipment. The books listed below should be available so that every member of the class may be able to consult them freely.

1. A good atlas containing physical as well as political maps. Longmans, Green, & Co., J. G. Bartholomew, Geo. Philip & Son, and several other publishers, all publish inexpensive atlases that meet the requirements. Every student should own an atlas.

2. A large commercial atlas. Bartholomew's Atlas of Economic Geography is excellent, but several others are almost equally good and less expensive.

3. A good encyclopedia, preferably Britannica or the International.

4. The World Almanac, Current Edition. Press Publishing Co., Pulitzer Bldg., New York.

5. The Statesman's Yearbook. Current Edition. The Macmillan Co., New York.

6. *Geography of the World's Agriculture. Department of Agriculture, Washington.

7. *Foreign Commerce and Navigation of the United States. Latest Edition. Department of Commerce, Washington.

8. *Statistical Abstract of the United States. Current Edition. Bureau of Foreign and Domestic Commerce, Washington.

9. *Year Books of the United States Department of Agriculture, Washington.

10. *Abstract of the United States Census. Census Bureau Washington.

11. *Atlas of the United States Census. Census Bureau, Washington.

12. Two or three elementary school geographies by different authors.

13. J. Brunhes: Human Geography; translated and edited by Dodge, Bowman and Lecomte. Rand-McNally Co., Chicago.

14. G. G. Chisholm: Handbook of Commercial Geography; Longmans, Green, & Co., New York.

15. Ellsworth Huntington: Civilization and Climate; Yale University Press, New Haven, Conn.

* Can be purchased at cost from the Superintendent of Public Documents, Washington, D. C., or can be procured through Congressmen or by direct application to the proper Bureau or Department.

16. Mark Jefferson: Commercial Values; Ginn & Co., Boston.
17. H. R. Mill: International Geography; D. Appleton & Co., New York.
18. Salisbury, Barrows and Tower: The Elements of Geography; Henry Holt & Co., New York.
19. E. C. Semple: Influences of Geographic Environment; Henry Holt & Co., New York.
20. J. Russell Smith: Industrial and Commercial Geography; Henry Holt & Co., New York.
21. R. DeC. Ward: Climate: G. P. Putnam's Sons, New York.

## Special Reference Books

Every class in the principles of geography should have access to a well-selected and not too voluminous assortment of (1) the best and most thoughtful books of travel and description, not more than two or three on any one country; (2) statistical books; (3) standard text books; (4) a few standard geographical sets, such as Stanford's Compendium of Geography, Appleton's Regions of the World, the Oxford British Empire Series, and Reclus' The Earth and Its Inhabitants, which though old is still unparalleled in interest and in the power of stimulating thought; (5) books on special topics such as soil, agriculture, irrigation, mining, forestry, manufacturing, transportation, and commerce; and (6) books giving statistics, descriptions, and historical accounts of the local city, county, and state.

Any reasonably good library contains a good deal of valuable material along the lines here suggested, and a year's experience will show the gaps that need to be filled. In choosing books of the six types here recommended, it must be remembered that a total library of only one or two hundred well-selected books, each of which is worth reading, is far better than several thousand books among which the student finds large quantities of chaff. Keep your reference books relatively few in number and high in quality, and make the students use them.

## Wall Maps

Effective teaching requires as full a series of wall maps as possible. These should include (1) relief; (2) political divisions; (3) summer and winter temperature; (4) summer and winter rainfall; (5) vegetation; (6) resources; (7) density of population; (8) transportation; (9) commerce and industry; (10) other conditions, such as occupations, race, religion, language, health, crops, manufactures, mineral products, and so forth. A series of world maps should first be procured, and then—as many continental maps as possible, beginning with North America, or the United States, and Europe. The Philips Series (American Agents, Denoyer-Geppert Company, Chicago) is excellent. The preparation of wall maps showing conditions not included in the published series is one of the best exercises for students of unusual ability. Large outline maps for this purpose can be procured through almost any dealer in geographical supplies.

# PRINCIPLES OF HUMAN GEOGRAPHY

## PART I

## *MAN'S RELATION TO PHYSICAL ENVIRONMENT*

## CHAPTER I

## HUMAN GEOGRAPHY

**Nature of Human Geography.**—All over the world the people of different places vary in appearance, dress, manners, and ideas. They eat different kinds of food, and enjoy different pleasures. They differ in the way they work and get a living, and in their government, education, and religion. Above all they vary in their capacity for work. Some, like the Scotch, are active in body and mind, and are able to make inventions or improvements. Others, like the Papuans of New Guinea, are slow in movement and so inactive in mind that they rarely think of doing anything, except as their ancestors did it.

These differences are the subject matter of Human Geography. They arise largely from differences in geographical surroundings, or physical environment, to use a more technical term. Hence, Human Geography may be defined as the study of the relation of geographical environment to human activities.

**How Human Geography Should be Studied.**—The science of human geography may be studied in many ways. One of the best is to think of it as a series of problems, or questions for which answers must be found. Some of these problems are large and complex like the problem of how far the progress of a given people is due to the geographical conditions under which they live. For example, why are the people of the forests of Central Africa primitive hunters and those of the steppes of Central Asia ignorant cattle raisers, while those of New Jersey are a highly civilized manufacturing and commercial people. So great a problem can be solved only through the solution of many smaller ones, such as the effect of rainfall, vegetation, and distance from the ocean, upon food, clothing, shelter, and tools, and especially upon man's occupations, health, and energy. Even such secondary problems, however, are too complicated to be easily solved. The way to solve them is first to study many minor problems. For example, even a child can see that since good grass does not grow in the forests of New Guinea, cattle cannot thrive there. It is equally easy to solve the problem of why the people of Central Asia, where the thermometer often drops below zero, wear sheepskin coats, while those of Central Africa, where a temperature of 70° is considered cold, wear almost no clothing. Thus Human Geography may be thought of as a vast series of simple problems leading to others that are more complex. To both student and teacher the solution of such problems becomes intensely interesting as soon as the spirit of the work is well understood.

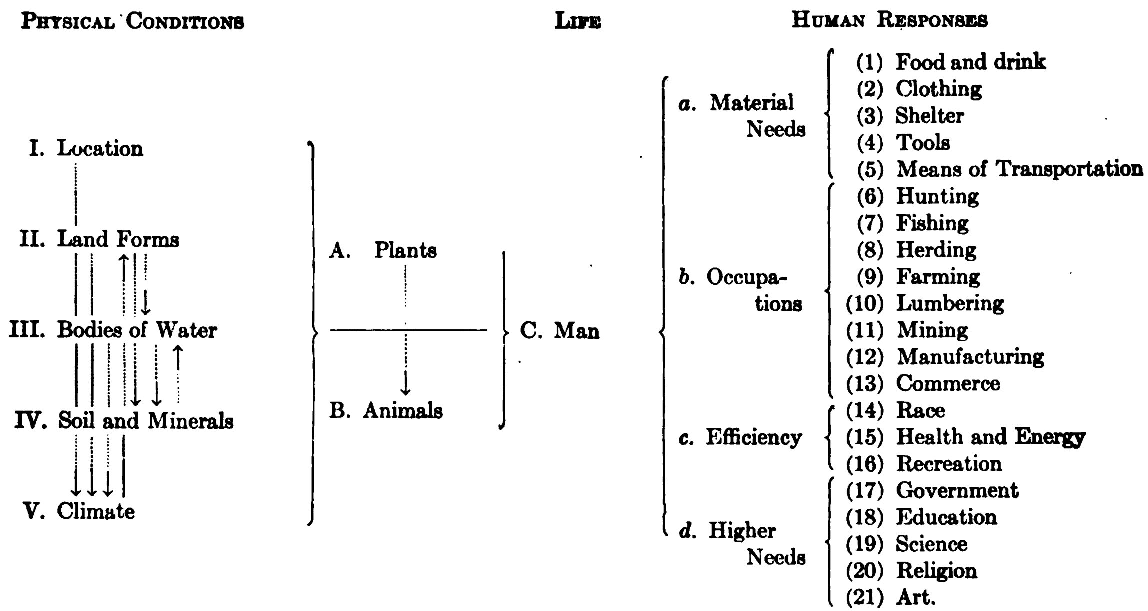
In this volume we shall study some of man's chief relations to his environment and find why these relations vary from one part of the world to another. While all the main phases of human geography will be considered, most of our attention will be devoted to the most practical parts, which are also the most interesting. The practical parts are the problems that are useable in our daily lives, those, for instance, that help us understand what we read in books, magazines, and newspapers, that enable us to discuss current events intelligently, and that guide us in plans for business or travel.

**The Elements of Human Geography.**—In spite of the vast number and great complexity of the problems of human geography, they can be classified into a few main types, the relation of which can be understood from Fig. 1.

I. **Location.**—On the left of Fig. 1 are the five chief features of man's geographical surroundings. The first is location. The location of a man's home is the most important of all the geographical facts that influence him. It determines whether he shall live in the torrid zone, the desert, or the frozen North. If his home is located in the interior of a continent, say in Colorado, he can scarcely be a sailor or a deep-sea fisherman. Again, location determines whether a person shall have only a few scattered neighbors, too backward to support schools, as in Labrador; or a multitude of progressive neighbors close at hand, as in Illinois.

II. **Land Forms.**—The effect of the form of the lands can be readily seen. The prairies of southern Illinois and the most rugged parts of West Virginia differ relatively little in climate, and only moderately in soil and altitude. But they differ greatly in density of population because rugged mountains provide almost no place for people to live. Because of relief such people as the Dutch move about freely and come

THE ELEMENTS OF HUMAN GEOGRAPHY.




The light arrows indicate the chief ways in which the physical conditions influence one another.

FIG. 1.

in contact with their neighbors, while others, like the Tibetans, are hemmed in by steep slopes, impassable valleys, and snowy passes.

III. **Water Bodies.**—Oceans, lakes, and rivers often separate country from country, and thus lead to great differences in race, language, and customs. On one side of the English Channel the people speak English and on the other French partly because the intervening body of water has prevented free intermingling. Bodies of water also serve as means of communication, and thus link people together. The hunter in Canada would find it difficult to travel far through the forest if he could not use his bark canoe on the many lakes and rivers. On a larger scale the harbors of New York, Liverpool, and Amsterdam, with their throngs of great ships, prove how closely the oceans link country to country.

IV. **Soil and Minerals.**—A large part of the world's wealth comes from the soil. Where the soil is fine-grained and deep, as in the plains of northern France and Ohio, the farmers are prosperous. A poor sandy soil, even with a good climate, may make a region poverty-stricken. For instance, in Mississippi and Alabama the chief physical difference between the sandy pine belt and the rich fine-soiled "black belt," where cotton grows, is the soil; but this difference makes one region the home of poor farmers who can scarcely get a living, unless large quantities of fertilizers are mixed with the soil, while the other is one of the most prosperous parts of the South.

Mineral wealth, as well as soil, is of vast importance. Without metal-bearing ores like those of the Upper Peninsula of Michigan, there would be no such thing as the machinery which runs the mills of Massachusetts. Other minerals such as the coal of Pennsylvania, and the petroleum of Texas, are the chief source of power for manufacturing and commerce. After the Great War the demand for petroleum was so insistent that every one of the great powers, including even Russia in the midst of its revolution, sent a commission to Mexico to try and get a share in that country's oil. At the same time the stricken people of Europe, who were almost starving, were crying to the United States for minerals, especially coal, almost as urgently as for food.

V. **Climate.**—The last of the five great features of physical environment is the most important. Climate enters into each of the other four, as shown by the arrows in Fig. 1. It depends on location; it is greatly influenced by land forms and water bodies, and influences them in return; and it has a great effect on the character of many soils. For example, the difference between the desert climate of the coast of Peru and the wet climate of the forested headwaters of the Amazon in Brazil is wholly due to the form or relief of the Andes.

On the other hand, the sand dunes of western China are the result of a desert climate, while the "Black Earth" region of Russia owes its rich soil to a moist climate.

Climate also determines the character of the plants and animals in different regions. It causes oranges and bananas to come from Costa Rica, and wheat from Minnesota. Still more important is the fact that man's energy depends largely upon climate. The Costa Rican planter cannot possibly work as hard as the Minnesota farmer. In the far North not only does the climate cause the Eskimos to be poorly nourished, but the steady cold benumbs their minds and bodies, and prevents progress. In the Congo forests, on the other hand, it hampers progress by favoring malaria and other deadly diseases. Only in countries like England, where the weather is variable, and not too extreme, can man be at his best.

**A. Plants.**—It is almost impossible to think of the five great features of physical environment without also thinking of plants. The location of Greenland reminds us of the absence of vegetation and the consequent impossibility of man's getting a living. When land forms such as plains, are mentioned, broad acres of rich crops come to mind, while the word "mountains" brings a picture of rough slopes covered with forests.

Even water bodies influence man through the minute plants which make it possible for fish to inhabit their cool depths, and thus lead men out over the stormy seas as fishermen. When it comes to soil there is almost no reason for thinking of it except as it enables corn, wheat, or grass, for example, to grow richly as in Iowa, while in other regions, such as the sandy parts of Cape Cod, it makes the crops almost too poor to be worth harvesting. Finally, to many people, the chief indication of climatic differences is vegetation. The date palm stands for dry hot deserts, the cocoanut palm for moist tropical coasts, the cotton plant for somewhat more temperate regions, and tundra moss for an arctic climate.

**B. Animals.**—Although animals are less important than plants, they influence man in a thousand ways. If there were no horses and oxen the prairies might have remained uncultivated, and in most parts of Europe and America the growth of a thick sod would make agriculture impossible. Without the sheep not only would our food supply be diminished, but we should not know where to turn for warm winter clothing. The only good substitute would be furs, but they, too, are derived from animals. Almost equally important in our daily lives are the cows, which give us the most perfect of all foods; while the hens that lay several billion eggs every year in the United States would be sadly missed if their cackle should forever cease. In many sections of Portuguese East Africa the tsetse fly not only kills all the horses, sheep, and cattle, but transmits to man a terrible wasting disease; while the malarial mosquito continually brings sickness and helps to make him ineffective. Even in our own land animals are harmful as well as helpful. The common or typhoid fly brings many dangerous diseases; and the disgusting rat not only consumes hundreds of millions of dollars' worth of property each year, but also spreads the plague.

**C. Man: How Man Responds to Geographic Surroundings.** (*a*) *Material Needs, and* (*b*) *Occupations.*—The total effect of physical environment upon man is summed up in the last two columns of Fig. 1 on page 3. The first of these two columns divides the responses into four great classes. In studying the first class, material needs, we ask: How do man's geographical surroundings determine the materials which he uses to satisfy his physical needs? In the second class come man's occupations, and here we ask: How does man supply his physical needs, that is, what occupations does he follow for this purpose?

(*c*) *Efficiency.*—While all men have material needs and all follow certain occupations in order to satisfy these needs, the energy which they put into their occupations varies enormously. Some are so lazy that they never work unless they are actually hungry, while others are so energetic that they work until they kill themselves. Such differences depend partly on race or inheritance, for some races appear to be naturally vigorous and especially gifted with brain power. The distribution of these races is a purely geographical matter. Nevertheless, it is not treated in this book, because the actual degree of ability among different races when placed in the same geographical surroundings and given exactly the same opportunities and training is not yet accurately known. Much of what is called racial character is due to the next item under efficiency; namely, health and energy, which depend largely on climate, but are in turn greatly modified by people's habits and especially by the way in which they spend their spare time, that is by their recreations.

(*d*) *Higher Needs.*—What man gets out of life is better measured by the way he supplies his higher needs—mental, esthetic and spiritual—than by the way he supplies his material needs. Every group of people has at least an elementary form of government, education, science, religion, and art. In one sense these things are not geographical. Yet the direction which they take, the resources which support them, and the degree of efficiency with which they are developed all depend largely on geographical surroundings. Although the way in which these higher needs are satisfied is the best measure of civilization, all the other classes of responses also play an important part. Civilization rises high only when all the material needs are well satisfied; when all the occupations are represented in proper proportion; when the higher needs are recognized as even more important than the lower; and when the pursuit of both the higher and the lower needs is carried on with efficiency.

(a) *How Geographical Surroundings Influence Man's Material Needs.*—In order thoroughly to understand the people in any part of the world we need to be able to answer each of these questions: What do they eat? How do they dress? What kind of houses do they live in? What tools do they use? How do they travel and transport goods from place to place? The answers depend largely on geographical conditions. Everyone must have food, but the man who lives on a certain remote island in an unfrequented sea must live largely on sago, cocoanuts, and pork, the chief products of his island, for the location is too remote to allow him to get food from other regions. If the island takes the form of mountains perhaps he may not be able to raise crops easily; while the body of water around him may cause him to get most of his food from the sea. If the soil is rich, the climate warm and damp, the vegetation luxurious, and food animals relatively few, as in the Philippines, the people will live on rice and bananas; but if the soil is gravelly, the climate dry, the vegetation merely short-lived grasses, and the number of cattle relatively large we shall find people like the cowboys of western Argentina who dry their jerked beef in the sun, and eat it with corn and beans.

So, too, with clothing and shelter. The thin cotton clothing, straw sandals, and thatched huts of the Hindu farmers could scarcely be used by the miners of Alaska for two reasons. In the first place, it is not easy to get the materials for such clothing and shelter in the far North, and in the second place, even if they could easily be procured they would not afford enough protection from the weather. The Yukon miner wants clothing of fur and wool, heavy leather boots, and a warm house of solid logs with the cracks well stuffed to keep out the cold. The tools and the means of transportation in India and Alaska show an equal diversity. The little hoes, wooden plows, ox-goads, and rude ox-carts of the Hindu farmer would be of little use to the northern miner who wants drills, hammers, and picks with which to dig into the solid rock, and freight cars or river boats in which to send away his ore.

(b) *How Geographical Surroundings Influence the Eight Great Occupations.*—In supplying their material needs the people of different parts of the earth generally follow the occupations in which their geographic surroundings give them the greatest chance of success. The Pygmies of the dense forests of Central Africa are wandering hunters not because they choose that occupation, but because no other is possible. The climate is so moist and the forest so dense that they cannot practice agriculture; the water bodies do not furnish any great amount of fish; cattle will not thrive; it is useless to cut lumber, for there is no market for it; there are no valuable ores, or else they are so covered with soil that no one has found them, and hence there is no mining; and more advanced occupations such as manufacturing and commerce are beyond the capacity of people who live in such surroundings.

Similarly on the Labrador coast, fishing is the only occupation which furnishes a fairly sure living, and even that is sometimes precarious. In Sonora in northern Mexico the climate is too dry for agriculture in many sections, but cattle can live on the short grass even though it dries up in a month or two. Hence the people are cattle herders.

In more favored regions such as Denmark the levelness and climate and the absence of other resources cause agriculture to be the great occupation.

In similar fashion the great forests are almost the only resource of the mountains of Western Sweden, so that the inhabitants have to be lumbermen, just as in Spitzbergen the low temperature and the presence of rich ores make mining practically the only occupation. England like Spitzbergen possesses valuable minerals in the shape of beds of coal and iron, and these not only foster mining, but cause manufacturing to take the lead. In Holland, on the other hand, the location of the country on the shores of the North Sea and at the mouth of the Rhine, between Germany and England, raises commerce to the leading position.

**Pennsylvania: An Example of Many Occupations in One Region.**—In the more advanced parts of the world several occupations are always carried on close together. One simple kind of occupation may have prevailed at first, but others are introduced until all are represented. In Pennsylvania, for instance, up to the beginning of the last century many Indians lived by hunting and fishing, and even to-day a few people are still supported exclusively in this way. Some of the early colonists lived by these same occupations, but most of them at once began lumbering in order to clear the land for agriculture. Even to-day many Pennsylvanians are engaged in lumbering, although this occupation is negligible compared with farming or mining, which rose to great importance after the steam engine was invented. The life of the farmers differs from the life of the miners as much as if the two lived in separate countries. After farming and mining had become well developed, manufacturing and commerce, which had formerly existed on only a small scale, began to be the occupations of large numbers of people, and are now of great importance. Thus, to-day in Pennsylvania, hunting, fishing, and lumbering are each represented on a small scale, while farming, mining, manufacturing, and commerce are all well represented. Such a development of many occupations is characteristic of advanced countries.

(c) *How Efficiency Depends on Geographical Surroundings.*—The great trouble with most people and with most races is not that they do not have ability, but that they do not make the most of what they have. They are lazy, or they lack will power, or find it difficult to concentrate on their work. Much of this inefficiency is due to lack of health and energy.

Health and energy, as everyone can see, are largely influenced by people's occupations and by the way in which their material needs are met. Many a man has poor health because he eats poor food, or eats good food too rapidly, or in too large amounts. Others lack energy because they dress unwisely, live in houses that are not properly ventilated, use machines that necessitate unnatural positions, ride too much in automobiles, or follow unhealthful occupations which keep them in offices and factories instead of outdoors.

These reasons for lack of health and energy are closely bound up with geography, because man's occupations, food, clothing, and shelter all depend largely on physical environment.

Certain geographic conditions, however, have a much more direct effect, and are so powerful that not even the strongest races have yet learned to overcome them. For example, the Dutch are a wonderful people, possessed of fine minds, and great energy; but when they go to such places as Borneo, where the climate is tropical, they soon cease to accomplish as much as in their own land, for they suffer in health and energy. This is due not only to distinct diseases, but to the direct effect of climate, as we ourselves see when we feel dull and listless in hot weather. Thus it appears that a considerable part of what we call the character of a race or nation, by which we often mean their efficiency, depends upon geographical surroundings.

(d) *Why Man's Higher Needs Depend on Geography.*—That country stands highest in which the greatest number of people take an intelligent and active interest in government, education, science, religion, and art. These means of satisfying the higher needs are much influenced by geographic surroundings even though they also depend largely upon racial character, the accidents of historical development, and the presence of men of genius. The geographical influences act through five agencies: (1) density of population; (2) degree of prosperity; (3) degree of isolation; (4) local differences in interests or resources, and (5) degree of energy.

(1) *How Density of Population is Favorable to Man's Higher Needs.*—Where the population is dense people can easily get together and talk things over; they can all be within the reach of law courts, election places, schools, churches, and art museums, and they can learn how to adapt themselves to new surroundings much more easily than can people who are scattered in small groups over a large area. That is one reason why southern Scotland is less conservative and better educated than the northern part of the country. Nevertheless the people of the North may be even more competent than those of the South.

(2) *How Prosperity and Poverty Influence the Higher Needs.*—Where favorable surroundings like those of Indiana make a community rich and prosperous it can afford to maintain a good government, and support teachers, scientists, clergymen, and artists. A region like eastern Quebec with poorer soil and a less favorable climate cannot afford to spend so much.

(3) *How Isolation is Unfavorable to Man's Higher Needs.*—China illustrates the effect of geographical isolation on the higher activities. Although Buddhism came from India, the intervening mountains have prevented the two countries from having much influence on one another. The sea long shut China off from the rest of the world. Now, however, the old isolation is breaking down. So we see the Chinese government change from an absolute monarchy to a republic; the old system of learning by rote gives place to study for the purpose of learning to think; writing with thousands of difficult characters gives place to a new system with only thirty-nine letters, almost as simple as our own; and witchcraft is beginning to be replaced by scientific medicine.

(4) *How Local Circumstances Alter the Responses to Man's Higher Needs.*—Geographical conditions often have a direct effect on the nature of art, religion, government, education, and other phases of civilization. For instance, the scattered location of the various parts of the British Empire causes the most progressive of them to be far more independent than are the States in our own country. In the same way because our States cover a large area and have different climates and different relations to the sea, they can be joined happily in a single country only if the various parts have more self-government than have the provinces of France, which lie close together and have only slight divergences of interests. Again in education, contrast the great number of trade schools in England, where coal, iron,

and other factors combine to encourage manufacturing, with the schools of a country like Argentina, where such subjects find no place.

So, too, Germany has turned especially to chemistry because the presence of rich deposits of unusual minerals, and the use of the beet for sugar gave the Germans great interest in that science. In like fashion the English, because of their wide use of the sea, have been the chief investigators of the science of oceanography; and California, by reason of its clear air, holds an uncommonly high place in astronomy.

Every religion is at least modified by its surroundings, especially those of its birthplace. The objects of worship are often determined by geography. In India where the coming of the rain is uncertain, the rain god is one of the chief deities. In the lofty plateaus of the Central Andes, where one is never warm, except when actually in the sunlight, sun worship prevails. In Egypt the Nile was once an object of religious adoration, since the Egyptians knew that their very lives depended upon it. The fact that both Judaism and Christianity sprang from a dry region where sheep herding is one of the chief occupations is evident in many parts of the Bible: "I am the good shepherd and know my sheep." "The shepherd giveth his life for his sheep." "The Lord is my shepherd; I shall not want. He maketh me to lie down in green pastures: He leadeth me beside the still waters." Such quotations reflect the chief occupation of Palestine.

The art of a country like Japan, where wood, silk, and copper are abundant and easily worked, and where stone cannot readily be procured, is bound to be very different from that of a country like Greece, where easily worked marble is far more common than good lumber, and where there is little silk and no metals. The Japanese build wooden temples with pointed roofs, and place in them paintings on silk and Buddhas cast in bronze, while the Greeks built flat-roofed temples of stone and filled them with marble statues. Not only the materials used in art, but the subjects show the influence of environment. In Japan venerable scraggly pine trees and symmetrical volcanoes are among the chief subjects of art, while in Egypt the lotus, a water lily of that valley, became the main ornament of architecture. Similarly the acanthus leaf was characteristic of the art of Greece where that bold handsome plant thrives in the dry soil. Even in the most progressive countries the art reflects local conditions.

(5) *How the Higher Needs Respond to Energy.*—Lastly, the degree of perfection to which a country carries its government, education, science, religion, and art, depends largely on the energy of the people; and that, as we have just seen, is influenced more by climate than by

any other one factor. Hence good-government clubs, educational societies, scientific associations, philanthropic organizations, and musical clubs are vastly more numerous in a country like Denmark, with a stimulating climate, than in a tropical country like Siam.

**An Example of Human Geography: Khirghiz Nomads of Central Asia.**—The nature of human geography may be illustrated by an example. Some of the Khirghiz of Central Asia are wandering herdsmen, or pastoral nomads, who live in the great Tian Shan Plateau of Central Asia in summer, and descend to the valleys and the lowland plain in winter. They are densely ignorant and superstitious. So low are they in the scale of civilization that they know almost nothing of manufacturing, science, and art. Their furniture consists of little except bags, saddles, and quilts. They eat their meals with their fingers from the common dish while sitting cross-legged on the bare ground or on the woolen rugs which are almost the only goods that they manufacture. Often their diet for months consists of sour milk, cheese, and meat with almost no bread and no vegetables or fruit of any description. According to our standards the Khirghiz are dirty, lazy, and unprogressive. Those who give up their usual mode of life and settle down to live permanently among the Russians of Siberia, become still worse, for they begin to deteriorate not only in character, but in health. To offset these unfortunate traits the Nomadic Khirghiz are delightfully hospitable, quite honest, and so bold and hardy that one cannot help admiring them.

**How Their Location Isolates the Khirghiz.**—In saying that the Khirghiz live in Central Asia we have already stated the main fact as to their location. It is necessary to add that they live in the "middle latitudes," since the center of that vast continent is midway from the equator to the pole. Nowhere in all the world is there a region more remote from the sea and from all the broadening influences which the great waters carry with them. On the south the great deserts of Chinese Turkestan and the huge desolate plateau of Tibet separate the Khirghiz from India and all outside influences in that direction. On the east and west they are also shut in by deserts so that they come in contact only with nomads like themselves—Mongols on one side and Turkomans on the other. Only toward the north, where the desert is less severe, do the Khirghiz come in contact with a civilized people, the Russians, but even that contact is slight. Thus isolation is the keynote of the Khirghiz location.

**How Plains, Mountains, and Plateaus Encompass the Khirghiz.**—Broad plains to the north and high mountains and vast plateaus to the south are the land forms among which the Khirghiz have their home. It is a wonderful experience to start in the broad plain and ride southward on horseback, with the Khirghiz. At first the plain is almost as level as the sea, and one's vision is limited only by the unbroken horizon, except where distant blue mountains break the skyline far to the south. The next day's march brings us among low hills; then the hills become so high and numerous that the trail winds up a valley instead of going straight toward its destination. Only after several days' riding, however, does it enter a real mountain valley, where the cliffs rise steeply on each side and the trail can scarcely find a foothold. When there is no room at the bottom of the valley, it must zigzag up a steep rocky slope, where a mis-step or an unnoticed bit of ice sometimes sends a horse tumbling hundreds of feet into the river. Finally, the valley opens out into a fine plateau, where broad, green basin-shaped plains lie pleasantly spread out at heights of 8000 to 12,000 feet. On every side rise snow-covered mountains, wonderfully tinted with blue or pink, and studded here and there with glaciers. Such are the wandering places of our Khirghiz nomads.

**The Part Played by Water Bodies.**—In the land of the Khirghiz there are salt lakes such as Balkash in the desert lowland, and fresh water lakes of rare beauty, such as Issik Kul among the mountains. These, however, have little effect on the lives of the nomads, except that certain dry lake bottoms furnish salt. Far more important are the rivers; for they serve as drinking places for cattle and because they have carved the valleys up which the Khirghiz climbs to the mountains. Such rivers are very hard to cross when the snow is melting in the spring. Sometimes a Khirghiz horseman tries to cross when the water is too high; his horse stumbles amid the boulders; and horse and rider are swept down several hundred yards in the icy water, and are fortunate if they can finally scramble ashore. Sometimes the streams cannot be crossed, and thus the trails are forced high up the mountain sides.

The most noticeable habit of the rivers is the suddenness with which they rise. By night in summer the mountains are cold and no snow melts, so that in the morning the rivers are low. By day there is much melting, and the streams swell rapidly. In some rivers the flood comes down at a regular hour each day, and the Khirghiz urge their horses to a gallop in order to reach the ford before the thick muddy tide of melted snow comes pouring down.

The most important of all water bodies to the Khirghiz are the springs beside which they camp. Among the mountains these are numerous, but in the dry lowlands, far from the rivers, they are so rare as to be very precious. In summer large stretches are uninhabitable because no drinking water is obtainable.

**Why Soil and Minerals Have Little Influence.**—Neither soil nor minerals have much effect on the Khirghiz. The soil is excellent, but its use is limited to grass since the climate prevents the growth of crops. The mineral wealth thus far discovered shows that some day it may be important, but isolation has kept the Khirghiz so backward that they have not yet learned to use the minerals of their mountains.

**The Nature of the Climate.**—The Khirghiz live so remote from the ocean that the winds have largely lost their moisture before they penetrate so far inland. Hence the lowlands are barren steppes. Fortunately what precipitation they get comes in summer rather than in winter, but it is never enough to support agriculture. The contrast of the seasons is great, for the summers are steadily hot, while the winters are long and bitterly cold with occasional fierce wild gales.

Among the mountains the fall of snow and rain is much greater than in the plains. In winter the mountains are so cold and snowy that no one can live there. In summer they are cool and wet, but not unpleasant. Frosts may occur at night on the plateau even in July, and showers are fairly common, but the bright clear days during much of the summer are delightful.

**How the Climate Determines the Vegetation.**—The plants that flourish in a climate such as that of the Khirghiz are limited. In the dry lowland plains there is a fairly good growth of short grass during the summer, but it is the thin grass of the steppes and not the rich verdure of the prairies. Where water is available for irrigation excellent crops can be grown, but such places are too rare to support any great number of people. As one passes from the treeless grassy steppes into the mountains a fringe of willow trees is often seen beside the streams, but there are no real forests until a height of perhaps 6000 feet is reached, where the rainfall is sufficient for tree growth. Above that for about 2000 feet the slopes are clothed with pine forests, but the total area of these is insignificant, for the heights soon become too cold for trees. Above the tree line grass again predominates. This time it is thicker, and more turfy than that of the lowlands. It is the beautiful, flower-studded grass of the Alpine heights for which the cool wet summer is ideal. In some places it grows a foot or more tall and is full of daisies, red peonies, and other bright flowers. Elsewhere it is shorter and spangled with thousands of wild pansies. Finally, near the snowline, the grass gives place to lichens and moss. Grass is the dominant vegetation of the home of the Khirghiz.

**The Wild Animal Life.**—In the steppes of southern Siberia and the plateau of Tian Shan where the Khirghiz have their home there are thousands of insects, birds, and mammals, but only a few which influence the life of man. The wild animals that he chiefly notices in the lowlands are antelopes, quail, and wolves. Herds of antelope browse on the dry grass. The quail feed on seeds and are themselves a great delicacy. The wolves not only sometimes stampede the horses that are turned loose at night to feed around the Khirghiz tents, but also kill many lambs. On the plateau the most important wild animals are two that live on the rich grass. One is the mountain sheep with its enormous curved horns six or more inches in diameter at the base. The other is the marmot, a small animal like a woodchuck. So abundant is the marmot that one can sometimes count a hundred in fifteen minutes, all browsing near their burrows or sitting up attentively on their hind legs beside their holes and ready to dive at the approach of danger.

**How Man Responds to Grasslands.**—In such an environment what mode of life should we expect? In other words, how is man to get a living? Since grass is the chief resource the best way is to keep domestic animals such as sheep, cows, horses, or camels. Since each family needs many animals the grass in any one place is eaten up in a month or two. Moreover, the most nutritious grass grows in the high plateau where it is deeply buried in snow except for three or four months in summer. Hence the most practicable mode of life is pastoral nomadism. That is, the Khirghiz must keep animals, and drive them from pasture to pasture. In summer he is on the high plateaus among the mountains with his flocks and herds, but as winter approaches the animals must gradually be driven downward to the lowest valleys, and out upon the plains where hay has been stored and where relatively permanent camps are occupied for three or four months in mid-winter.

**Why Animals Furnish Most of the Food.**—Such being their mode of life, let us see how the Khirghiz respond to the environment in other respects. Why is their diet so largely limited to milk, cheese, and meat?

Since the summers are too cold for gardens, vegetables are almost unknown. Meat, too, is by no means eaten regularly, as one might suppose. Some of the young animals that grow up each year must be kept to increase the flock, and replace those lost in storms or eaten by wolves. Most of the rest must be exchanged for flour, cloth, knives, or other necessities. Hence only a few can be eaten. Milk is the staple food. Part of it is made into butter or hard sour cheese, and kept for weeks or months. The rest is used at once, but not till it has become sour. The Khirghiz have learned that if milk is used in large quantities, it is much more healthful sour than fresh.

To many a Khirghiz boy or girl bread is as much a luxury as is cake to a child in America. The flour must be brought long distances on horses or camels. The supply may be exhausted long before the summer stay in the mountains is over. A Khirghiz mother often takes great pains to stow her little store of bread where the children will not find it and be tempted to eat it without permission. As there is no fuel except dry grass or the dried dung of animals, and as stoves are too heavy to be easily transported, the bread is baked in thin sheets over open fires, or perhaps the dough is cut into cubes and boiled in fat like doughnuts.

**The Relation of Clothing to Environment.**—The clothing of the Khirghiz is fitted for life in the cool damp mountains in summer and in the cold lowlands in winter. At all seasons both men and women wear thick padded gowns that shed the rain, and high boots for walking in the wet grass and among the cattle. Much of their clothing is made from the wool of their sheep and the skins of their animals. The men wear great caps of sheepskin with the wool on the outside, and everyone has a sheepskin coat made so that it can be worn with the wool in or out according to the weather. The women wear head coverings of cotton cloth from Russia. They wind long embroidered strips into head-dresses a foot high. Both men and women keep their hands warm and dry by means of sleeves that extend down a foot or so below the hands. It is amusing to watch them throw back their sleeves when they eat, or begin to work. The necessity of selling animals to obtain cloth for clothing is one of the chief reasons for what little commerce there is among the Khirghiz.

**The Movable Homes of the Nomads.**—People who frequently migrate must use a shelter that can readily be taken down, packed on animals, and set up in a new site. A tent is admirably adapted to such purposes. The tent of the Khirghiz is round and covered with a thick felt made from the wool of their sheep. A folding lattice fence of willow forms a circle twelve to fifteen feet in diameter. From the top of this, light poles converge upward toward a large circular opening. Over the frame-work thus formed, the felts are smoothly stretched, and are most effective in keeping out cold, rain, and wind.

**The Tools of Pastoral Nomads.**—Under the heading tools we include not only ordinary tools, but all kinds of implements, utensils, and even machines—in fact everything that people make in order to help themselves in some occupation. Since all of a family's goods are carried on the backs of animals every few weeks, especial kinds of

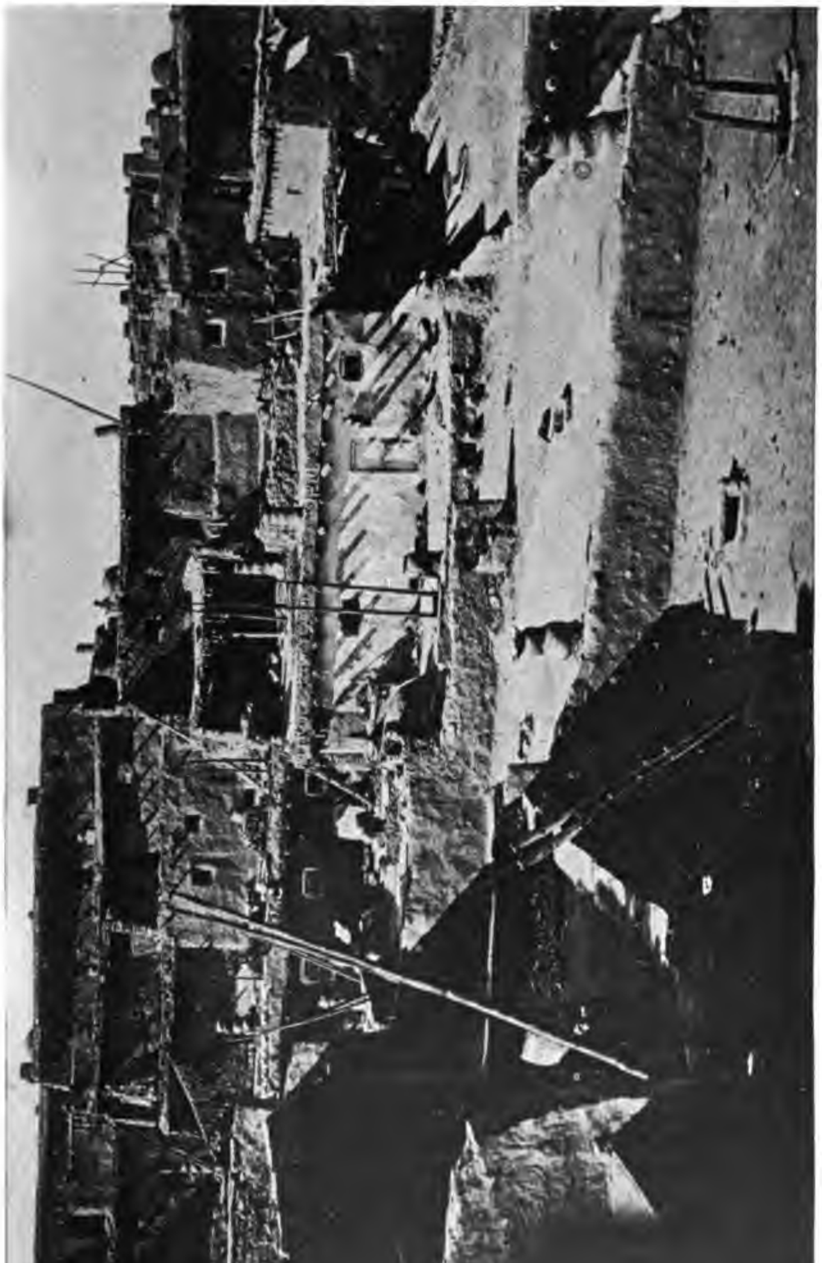


FIG. 2.—A Pueblo Village in Arizona.

**Desert architecture in a region of scanty rainfall, sparse timber, and abundant clay.**

utensils are needed. China dishes are too breakable and metal bowls too heavy. Therefore, milk, cheese, and butter are kept in whole sheepskins partially tanned. When the family sits down to a meal a great wooden bowl holds the sour milk, soup, or meat. As forks and spoons cannot easily be made and are a luxury beyond the reach of the Khirghiz, everyone eats with his fingers from the same dish. Since furniture is too awkward and heavy to be transported on the backs of animals, rugs from the wool of the sheep take the place of chairs, tables, and beds.

FIG. 3.—Erecting a Turkoman Tent in Transcaspia.
The Turkomans, like their Khirghis neighbors, live in round felt tents that can be easily set up.

**How the Khirghiz Family Moves.**—A Khirghiz migration is an interesting sight. At dawn a group of tents stands on the green turf at the base of a high cliff. An hour later the tents have been pulled down by the women, while the men have started on the day's journey with the slow-moving sheep. A five-year old child leads a snarling camel to the pile of felts, poles, and lattice where his mother has just pulled down the tent. A jerk on the rope tied to a pin in the creature's nose makes it kneel in spite of its fierce snarls. The mother and an older boy tie the tent poles, a box or two, and some bags and rugs on the animal's back. A big sister fastens some wooden bowls and some sheepskins of sour milk and cheese on one side, and on the other ties the baby's cradle. The baby is put into the cradle, a big rug is tied firmly over it, and the camel, grunting and complaining, is led away to take his place at the head of a string of other camels. The mother and all the children down to the five-year old youngster follow on horseback. By nightfall the tents are set up ten or fifteen miles away and the new encampment looks as comfortable as the old.

**The Work of Cattle Herding.**—The life of the cattle herder is sometimes easy and at others very strenuous. Some of the men go out with the sheep and sit around all day doing nothing except occasionally bring back a straying sheep. Others on horseback, round up the cattle or yaks to see if all are on hand and perhaps to pick out one for sale; still others, with nooses tied to the end of what look like fishing poles, gallop off to catch horses when more are needed.

Occasionally, however, the Khirghiz must ride all day to recover stray animals. Wolves must sometimes be fought, while during the great snow storms the sheep must be carried to safety, one by one. Thus the Khirghiz men are forced to tremendous exertions for a while. They come back to the tents so tired that they lie down and do almost nothing for days. As the women milk the animals and do all the routine work the occupation of herding tends to make the men lazy. They laugh at the danger of fording a roaring torrent, which makes the city man pale, but they do not know how to stick to hard, steady work, for their occupation does not require it.

**Why Manufacturing and Commerce are Backward.**—This lack of steadfastness, the difficulties of transportation, the isolation, and the lack of other incentives cause Khirghiz industries and commerce to be poorly developed. The women weave, or rather knot, beautiful rugs of wool, which are prized even in Europe and America for their harmonious colors and pleasing patterns. The women also make gay felts by beating wool of various colors into a firm waterproof mass; the skins of animals are tanned; and a few other simple operations are carried on. From the materials available to pastoral nomads, the Khirghiz make the things that they need and can easily carry, but that is the limit of industrial development.

Commerce is equally backward. In the autumn droves of sheep, horses, and camels, and perhaps a few cattle are driven to a distant town for sale. Flour, cloth, guns, and other small articles are brought back. Even in these simple transactions—their only commercial dealings—the nomads are frequently cheated by the city men, for though the Khirghiz dare traverse the most narrow and dangerous trails, their daily life gives them no skill in the art of buying and selling.

**Are the Khirghiz Efficient?**—It is not easy to measure the efficiency of the Khirghiz. So far as we can determine, the Turanian race to which they belong probably stands lower in mental power than does either the white race or the yellow Mongolian race to which the Chinese belong. We have seen also that their occupation tends to make the Khirghiz lazy and inefficient. As to health no figures are available, but the Khirghiz are probably not long-lived. They seem strong and hearty, however, and the outdoor occupation of both men and women as well as the life in the open tents is certainly beneficial. How valuable these are is evident when the Khirghiz move to the Russian villages and live in close stuffy houses. Under such circumstances their health suffers at once. Even when living out-of-doors the Khirghiz have some disadvantages. The winter is so long, cold, and monotonous, that it saps their vitality. Little fires of the dried dung of cattle are the only help against the cold. The cool summer, however, is excellent, except that there is a good deal of exposure to dampness and chills.

*The Exhilarating Recreation of the Herders.*—That the Khirghiz are strong, hardy people is evident from their favorite games. In one of these the players are on horseback. Their object is to see who can skin a dead calf and carry off the hide in spite of the attempt of the others to pull it away and skin it themselves. At first the calf is thrown on the ground in the midst of a circle of riders. At the word everyone whips his horse into the center and all lean over and try to pick up the dead animal. The one who finally gets it darts out of the plunging, kicking group of horses, throws his leg over the calf and whips out his knife to begin skinning it as he rides. The horses gallop furiously, the men shout wildly, and one thinks that half the band of riders will be killed. Finally a skillful rival overtakes the leader, yanks the calf from under his leg, and goes on with the skinning. The same thing soon happens to the rival; and so it goes until someone dares gallop down a treacherous slope or ford a rushing river, and thus get far enough away from the rest to pull the skin off, and thus win the prize. Such a game is as good a recreation as could be devised, for it gives health, strength, and good sport, and also efficiency in the hardest part of the herder's occupation.

**How Environment Influences the Higher Needs of the Khirghiz.**—Where geographical conditions cause nomadic herding to be the chief occupation, man's higher needs are usually neglected. Thus the Khirghiz, secure in their remote grasslands, pay little attention to the central government. If a crime is committed, if a feud breaks out, or if a new trail is needed, they take the matter into their own hands. In each group of relatives who pitch their tents together the oldest, or the most competent of the older men is the chief or patriarch. He rules by his sense of justice and by the dictates of custom instead of by written laws such as we submit to.

Among nomads like the Khirghiz education and science are even less developed than government. The individual communities are too small to have schools. The absence of contact with outside people and their own lack of inquisitiveness prevent the Khirghiz from making scientific discoveries. In religion they are content to follow many Mohammedan customs, but are too isolated to get any new ideas or even to follow fully the practices of other Mohammedans. Art finds almost its only chance for expression in the woolen rugs, bags, and felts which the Khirghiz use for many purposes. Thus civilization remains stationary. The Khirghiz are not savages, but the gulf between them and the more enlightened nations is growing wider. The influence of European civilization has begun to reach them, but their mode of life will probably change only a little so long as they depend chiefly upon the grass of the plains and high plateaus.

**Geography and other Influences.**—In spite of its great importance, as illustrated by the life of the Khirghiz, we must think of geography as only one of the factors that influence human character. Some persons are born with high ability and some without. A man of great energy and a fine mind even in a debilitating climate far from educational advantages and other opportunities, is worth more than a weak stupid man who lives in the most favorable place in the world. Even an apparently dull boy who has the determination to make himself of value will succeed better in a poor environment than will a bright boy who lives amid better surroundings, but has not the will to live up to high ideals. So, too, the right kind of government, a good education, or a religion which leads people to serve the public instead of seeking their own petty ambitions may make people amount to more in a poor environment than in a good one without such influences. Moreover, mankind is constantly learning to overcome the influence of unfavorable circumstances, and is even causing them to help him. Thus although good geographical surroundings are highly desirable, it must constantly be remembered that they are only one of the great factors which determine the progress of a nation.

## QUESTIONS, EXERCISES AND PROBLEMS

1. Write a description of your home region on the model of the Khirghiz.
2. Compare the industries and recreation of the people who live in your State

with those of the Khirghiz, or some other people. What are the qualities of mind and body developed in each by the activities of daily life?

3. Classify the twelve chief raw materials used for the food and clothing of the people of your home town according to (*a*) whether they are animal, vegetable, or mineral, (*b*) whether they are imports or domestic products.

4. Compare the geographic environment of Joseph and his brethren in Egypt with that of their Jewish descendants of the East Side of New York. Point out how this would cause differences in respect to the human responses included under (*a*) material needs, (*b*) occupations, in Fig. 1.

5. Write a comparison of Figs. 2 and 3, in order to show what these two types of dwellings illustrate as to the effect of environment on (*a*) occupation; (*b*) raw materials, (*c*) methods of house building.

6. Select some backward region that especially interests you in any part of the world. On the basis of your own knowledge and of accounts in encyclopædias, reference books, books of travel and magazine articles, write a geographical description. Use the Khirghiz as a model. Pick out the most important features of the geographic environment and treat them with special fullness.

7. Select some progressive region and treat it in the same way. As you treat the different topics explain why in some of them progressive people are much more difficult to describe than unprogressive.

# PART II

## *MAN'S RELATION TO LOCATION*

## CHAPTER II

## THE EFFECT OF THE EARTH'S FORM AND MOTIONS

**The Earth as a Globe.**—In the diagram on page 3, location stands first because upon it depend a great many other geographical conditions such as distances and climate. The only possible way of stating the location of a place is by giving its position in reference to something else. The fact that the earth is a rotating globe is highly important in this respect, for it means that the earth has two fixed points, the poles, whose position can be determined with absolute precision and in reference to which all other positions can be fixed. The equator, for example, is merely an imaginary line half way between the poles.

The evidence that the earth is a globe is abundant. The hull of a distant ship disappears before the sails or smoke stacks. Hence the intervening surface must be curved. The altitude of the stars changes by a practically uniform number of degrees for each hundred miles that one travels northward or southward. This is possible only on a globular earth. Moreover, thousands of people have actually gone around the globe in many different directions since Magellan's first circumnavigation.

The evidence that the earth rotates on an axis is not so clear as the evidence that it is a globe. The sun, moon, and stars, to be sure, rise and set as if the earth rotated, but this might be because each heavenly body revolves around the earth, as was supposed by the ancients. So firmly was this idea established that when Galileo announced that the earth's rotation accounts for day and night and the rising and setting of the stars, he risked violent persecution and even death. One of the most convincing proofs that the earth rotates is the course of a ball dropped from a great height. Barring a slight deflection due to the varying density of different parts of the earth, a plumb line suspended from a lofty structure such as the Eiffel Tower in

Paris points straight toward the earth's center. If a ball be dropped from the point of suspension, it will not strike the earth at the point toward which the plumb line was directed, but an inch or more to the east. During the few seconds while the ball is falling both ball and earth move eastward by rotation. The ball falls perfectly straight, but it has an eastward motion greater than that of the point below it.

**The Meaning of Latitude and Longitude.**—The relation of latitude and longitude to the globular form and rotation of the earth may be illustrated by an umbrella. The handle represents the earth's axis upon which rotation takes place. It passes through the cloth at the pole, while the lower edge of the cloth, if it were straight instead of scalloped, would represent the equator. The ribs represent meridians by which longitude, or angular distance east or west, is measured. Circles parallel to the umbrella's lower edge would correspond to the parallels by which latitude, or angular distance north or south is measured. If a marked rib serves as the prime meridian of London, the position of any point on the umbrella may be indicated as so many degrees of longitide east or west of the prime meridian, and so many degrees of latitude from the equator. All these relationships, as they appear upon a globe, are shown in Fig. 4.

FIG. 4.—Latitude and Longitude on a Globe.

Although latitude and longitude are angular distances they can readily be converted into distances in miles provided the size of the globe is known. The length of a degree of latitude is everywhere about 69 miles, while a degree of longitude has the same length at the equator, but decreases steadily until it becomes nothing at the poles where the meridians converge.

The distinction between longitude and latitude can easily be remembered by bearing in mind that longitude not only runs to 180°, but is the *long* dimension of the Mediterranean Sea where the terms were first used. Latitude runs only to 90°. The word comes from the Latin for "wide," meaning the width of the Mediterranean.

Another point to remember is that high latitudes are not only designated by high numbers both north and south of the equator, but are those which would be highest on the umbrella of our illustration. The continent of Antarctica is in high latitudes, while Ecuador, which means Equator Country, is in low latitudes. Our own country is in the middle latitudes, which are the best parts of the world.

A good example of the use of latitude and longitude is the way it enables ships at sea to state their exact position. When the *Lusitania*, for example, was torpedoed by a German submarine in 1915, it sent out a wireless message that it was in 51° N. latitude, 9° W. longitude. Instantly the ships receiving the message hastened to the exact spot even though it was far beyond their vision. Though the *Lusitania* sank in twenty minutes many people were saved. An airplane in crossing the ocean asks the latitude and longitude of every ship that it passes, in order that the aviators may know just where they are.

**How Time is Determined.**—In order to ascertain the location of a place on the earth's surface, time as well as latitude and longitude must be employed.

The sun is the natural time-keeper for all the world. When people first made careful measurements of time they based their reckonings on the hour at which the shadow cast by the sun is shortest. This gave the simplest form of "local" time, but it was ultimately found that the days measured in this way vary in length, because of the earth's varying rate of motion around the sun. By making corrections on this basis, they obtained what is called "mean" time, according to which twelve o'clock is the *average* time at which the sun reaches its highest point throughout the year. This was an important step. Today, however, local mean time is rarely used in progressive regions. It is not convenient in these days of railroads, automobiles, air planes and rapid travel, for no two places have the same local time unless they happen to be on the same meridian. When railroads were introduced each railroad used the time of the city where its headquarters were located. At railroad junctions there thus were often different times. In one town *five* systems were in use as late as 1880, while in the United States as a whole the railroads ran on 53.

To obviate this confusion the present system of "standard" time was adopted with only four belts. These belts are based on longitude. Since the earth rotates 15° an hour, the railroads in 1883 agreed to use only the local time of certain "standard" meridians that are multiples of 15°. The country is divided into belts lying on either side of these meridians.

The most easterly belt uses the time of the meridian 75° west of Greenwich. *Eastern Time*, as it is called, is therefore five hours behind that of London. The next, or *central time* belt, uses the time of the 90th meridian, six hours behind London; while the *mountain* time of the 105th meridian and the *Pacific time* of the 120th are

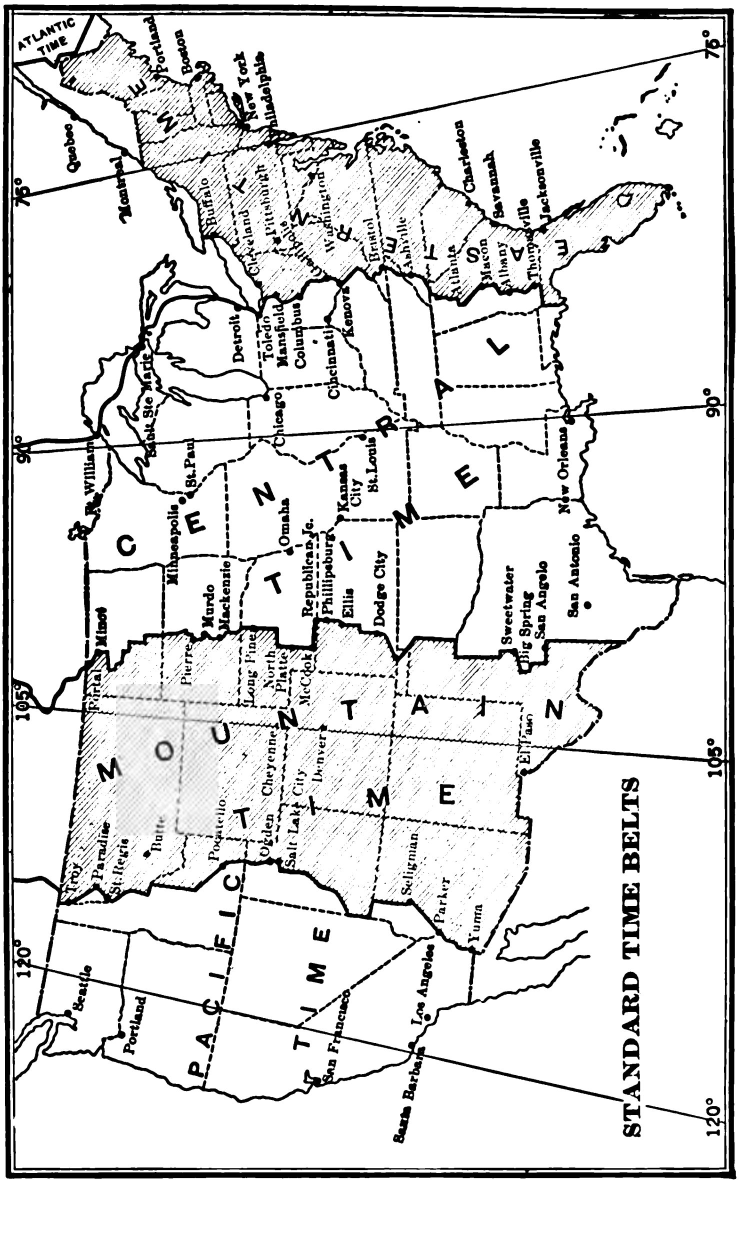



FIG. 5.—Time Belts in the United States.

respectively seven and eight hours behind London. This system is very convenient, for people do not need to change their watches except on passing from one belt to another, and then the change is always exactly one hour. The standard time belts of the United States are shown in Fig. 5. As the railroads prefer to change time at division points where new trains are made up, rather than in the middle of long runs, the belts are irregular in shape.

**How Travelers Gain or Lose Time.**—On a journey around the world the time changes twenty-four hours. In 1519 Magellan left Spain with five ships to make the first voyage round the world. When his sole surviving vessel reached Spain three years later the crew cound not understand why their reckoning made the date September 6, while the people at home said it was September 7. No mistake could be found in the ship's records, and the travelers were much puzzled until Paoli Sarpi told them that during their adventurous voyage they had lost a day by going around the world with the sun. If they had gone eastward, they would have gained a day, and would have recorded the date of their return as September 8.

The explanation is simple. Suppose a traveler starts from London at noon on Monday, and travels westward at the rate of 15° a day. Since 15° of longitude are equal to an hour of time, the sun at the second noon will reach the zenith an hour later than at London. Therefore at noon by the sun on Tuesday, the traveler's watch will say 1 P.M., and he will have to set it back an hour and will actually have twenty-five hours in his day. Such changes in the clock are made regularly on ships that cross the Atlantic. The change, however, is generally less than an hour, for only in high latitudes can ships travel through 15° of longitude in a day. On Wednesday, if the traveler continues westward at the rate of 15° a day, a change of another hour will be necessary. London time will now be ahead of the traveler's by two hours, for each of the traveler's days has been twenty-five hours long instead of twenty-four. If he keeps on around the world he will traverse 360° of longitude, and change his time twenty-four hours. Whether he travels slowly or rapidly he will gain the same amount of time in traveling the same number of degrees, and when he gets back to London he will have gained a whole day.

Of course such a traveler does not really live twenty-four hours more than his friends who stay at home; therefore, in order to have his calendar correct he must skip a day, that is, move the date ahead one day to make up for the twenty-four hours which have been added bit by bit to his other days. In traveling eastward the days are shortened instead of lengthened, and the watch must be set ahead instead of back. A certain amount of the twenty-four hours is lost out of each day. As the days are shorter, they pass more rapidly than a home, and when the traveler gets back to his starting point his reckoning will be one day ahead of that of the people who have stayed at home. Therefore, he must set his calendar one day back, that is, repeat one date.

**Where Days are Lost or Gained.**—Whichever way one travels around the world the date must evidently be changed somewhere. If each person changed when he finished his journey, it would cause great confusion. The easiest place to change the date is the 180th meridian, for this lies almost wholly in the ocean, and comparatively few people cross it. For convenience the actual *International Date Line* is a little zigzag, as shown in Fig. 6, for the Fiji and Chatham Islands prefer to have the same day as New Zealand, while the Aleutian Islands wish to be like the rest of Alaska. Whenever a ship crosses this line it adjusts its time, that is, drops the next day of the calendar if bound westward and adds a day usually called Meridian Day if bound eastward. Perhaps the only unhappy result of this arrangement is to the boy whose birthday may fall upon a lost day.

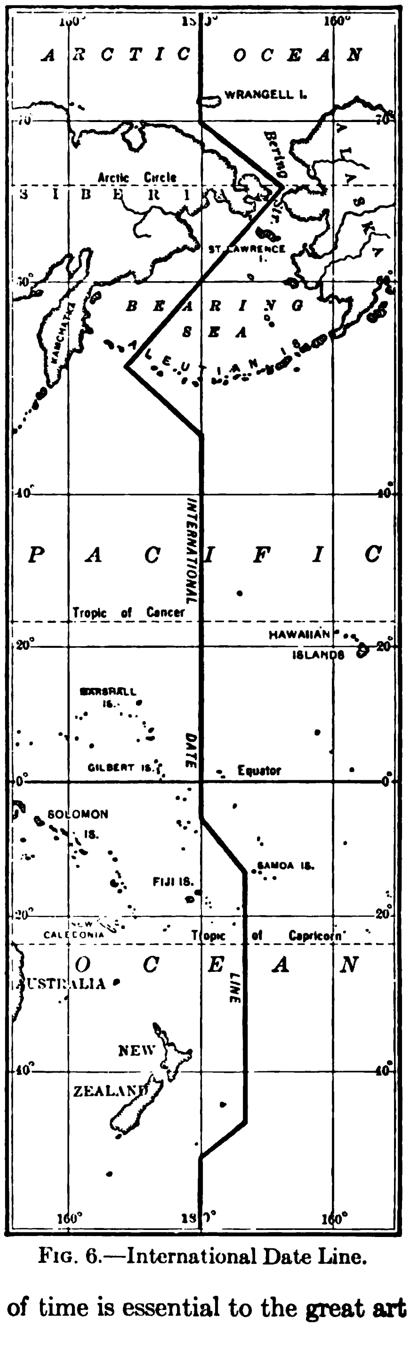



FIG. 6.—International Date Line.

**How Navigators Find Their Location.**—An exact knowledge of latitude and longitude and also of time is essential to the great art of navigation. The sea captain has no mile posts or signals to guide him as has the engineer on a locomotive. He cannot even measure his speed with perfect accuracy. His ship, to be sure, is equipped with a log or little wheel that drags in the water far astern and measures the distance like the speedometer of an automobile. The mariner also knows how many revolutions the propeller makes and how far each is supposed to send the ship forward. Yet since the speed and direction of ocean currents are not constant, one cannot be sure how much of the distance indicated by the log and propeller is due to the actual movement of the ship and how much to the currents. Moreover, the mariner cannot always be sure that his ship is moving in the right direction. Its prow may always

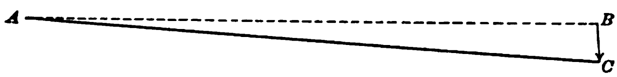



FIG. 7.—Position of a Ship by Dead Reckoning and by Observation.

A—B = Course by dead reckoning.
B—C = Unreckoned drift.
A—C = Actual course.

point right, but an unusually strong current or wind may carry the vessel many miles from its true course in spite of all the mariner's corrections.

When the navigator approaches land such mistakes are most hazardous unless he can correct them by determining his exact location. In other words, he must be able to determine his latitude and longitude, and thereby correct any mistakes that he has made in his "*dead reckoning*" from the log and propeller and from his direction as determined by the compass.

**Latitude at Sea.**—Wherever one may be, the number of degrees from the zenith to the noonday sun is always equal to the number of degrees between the observer's position and the part of the earth where the sun's rays are then falling vertically. The "Nautical Almanac"[1] tells the mariner exactly where the rays are vertical at any given time. Hence the only thing for him to do is to measure with his sextant the number of degrees in the angle between his *zenith* and the noon-day sun and add or subtract the number of degrees by which the vertical rays are north or south of the equator. For convenience, however, the mariner actually measures the distance from the horizon to the noon-day sun, and subtracts this measurement from 90°. This is merely because the horizon can easily be

[1] The American Ephemeris and Nautical Almanac is to be obtained for a small fee from the Supt. of Documents, Gov't Printing Office, Washington, D. C.

located while the zenith is not definitely marked. At sea the zenith, of course, is always 90° from all parts of the horizon.

**Longitude at Sea.**—While determining his latitude the mariner may determine the hour of local noon, by finding the exact moment when the sun is highest. Knowing this he can determine his

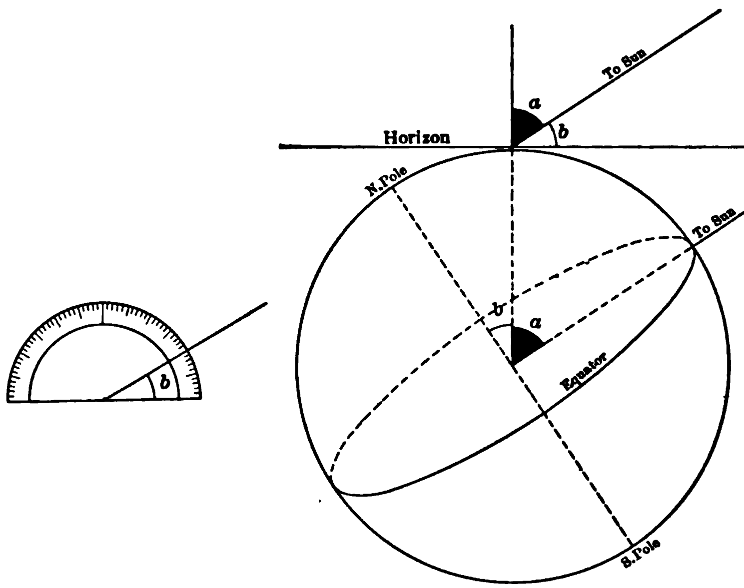



FIG. 8.—Use of the Sextant.

The little diagram on the left shows a graduated circle on which the angle *b* has been measured. A sextant has a similar graduated arc on which the observer measures the angle between his horizon and the noonday sun. Such an angle is shown at *b* in the upper part of the main diagram. At the equinoxes, when the sun is vertical at the equator, the latitude of the place of observation is measured by either of the angles marked *a*, since the lines marked "to sun" are parallel. But the angle *a* is evidently equal to 90°-*b*. Hence, to find the latitude at any time of the year it is merely necessary (1) to measure the angle *b* at noon with a sextant, (2) to subtract *b* from 90°, and (3) to add or subtract the latitude where the sun's rays happen to fall vertically on the date in question as given in the Nautical Almanac.

longitude by simply comparing local noon with Greenwich time which is always kept on ships by clocks of remarkable accuracy, called *chronometers*. In practice he makes another observation for this earlier in the day.

Since any place on the earth's surface rotates through 15° in one hour, there is a difference of 15° in longitude for every hour of difference between the mariner's local noon and the time indicated by the chronometer. Thus if local noon occurs when the chronometer reads 1 p.m. the ship is 15° from the prime meridian. Since local time is behind Greenwich time the ship is west of the prime meridian. Hence the longitude is 15° W. Suppose that local noon came at 9.40 a.m. by the chronometer. In this case the difference in time is two hours and twenty minutes, which is equivalent to 35°. Here local time is ahead of Greenwich time. Hence the ship is east of the prime meridian, and the longitude is 35° E. When the mariner has determined both latitude and longitude, he knows exactly where he is, and can locate the spot on his chart of the sea on which he is sailing. The more important points upon maps are first located by methods like those used by the mariner. Then when the latitude and longitude of many places are known, the map can be drawn.

**How Maps Depend on the Earth's Form and Motions.**—The shape and movements of the earth and its relation to the sun are of primary importance not only in determining latitude, longitude, time and the seasons, but in determining how maps shall be made. If there were no equator and poles, and if the earth's rotation did not cause the sun and stars continually to move through the heavens, there would be no such thing as locating points by means of observations of latitude and longitude. Because of the earth's rotation an explorer in Central Africa with his sextant and chronometer can put a newly discovered town on the map with a high degree of accuracy in an hour. If the earth did not rotate and were of irregular shape the only way to make maps would be by direct measurements from some center, such as London. Accurate measurements, however, would cost hundreds of dollars per mile by land, and would be almost impossible by sea. Thus, the accuracy and completeness of the art of mapmaking depend directly on the earth's form and motion.

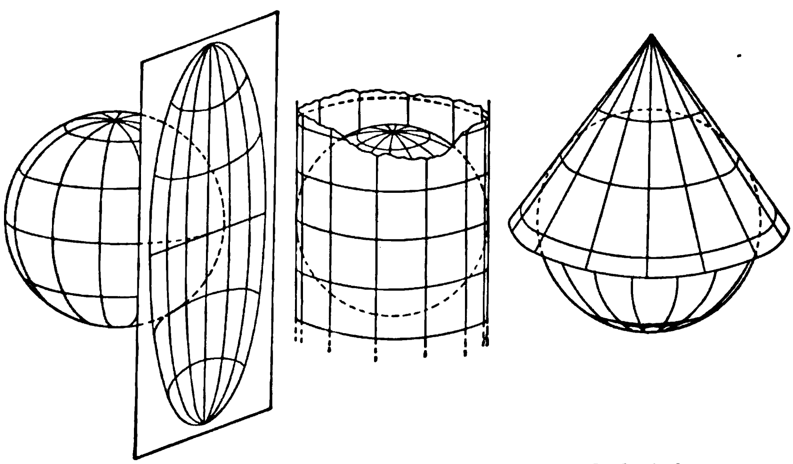
**Why Maps are Important.**—It is impossible to study geography intelligently without maps. The primary purpose of maps is to show location. It is easy to say that a large city is located approximately in north latitude 30° and west longitude 90°, that it is on the Mississippi River 107 miles from its mouth, close to Lake Pontchartrain, and that it is 140 miles southeast of Mobile and 165 south of Jackson, Mississippi. But how vastly easier it is to look at a map and see at a glance the relation of New Orleans not only to the mouth of the Mississippi, Lake Pontchartrain, Mobile, and Jackson, but to hundreds of other rivers, towns, mountains, bays, gulfs, and other geographical features. Thus a map is chiefly useful because it shows the location of a great many features and their relation to one another both in distance and direction. In fact, under the heading " location " in Fig. 1, page 3, maps are by far the most important item. We fully realize their importance only when we are in circumstances like those of prisoners in Germany, for example, during the Great War. At that time maps were so important to any man who wished to escape that prisoners made little maps on their finger nails, inside their shoes, or in almost any place that they thought would not be noticed by their German guards. Even these inadequate maps helped them to find their way out of Germany when they had escaped from prison.

**What Can be Shown on Maps.**—Although the purpose of all maps is to show location, they are equally useful in showing any of the other items of the table of Fig. 1. For instance, almost every one is familiar with relief maps which show land forms by means of hachures, shading, contour lines, or colors. Most maps show lakes and rivers, but maps of minerals and soils are less common, although they are used by every intelligent mining man, and by many of the most up-to-date farmers. In the same way climatic maps are very common. Each day the Weather Bureau gets out a map showing the atmospheric pressure, winds, temperature, and cloudiness for the whole United States. By studying the weather map wide-awake firemen in large buildings save thousands of tons of coal. Many a mariner, fruit raiser, and shipper studies these maps with the greatest care, for he knows that his profits may be destroyed if he reads the map incorrectly.

Other conditions, such as the distribution of plants or animals, can readily be put on maps, as can every one of the human responses in the table of Fig. 1. Such maps may tell where fishing is the prevailing mode of life, for example; the location of banana plantations; where people live in adobe houses, or wear wooden sandals instead of leather shoes. They may also show where people have much energy, where influenza is most common, where cotton goods are manufactured, where caravans are used most largely in transportation, where coal is an important article of commerce; where people worship idols, where democratic forms of government prevail, where baseball is a favorite recreation, and where civilization is high.

**How Maps Help Explain Geographical Distribution.**—In the preceding paragraph examples have been given of maps pertaining to each of the elements of geographical environment and many of the human responses as given in Fig. 1. Notice that in every case something is said about location or else the word "where" is used. That word furnishes the key to the value of maps. But to know where anything is located is not enough; we must also know why. Many times we can determine why by comparing one map with another, and such comparisons are one of the most important features of human geography. Only by a comparison of maps showing density of population and rainfall, for example, can we clearly understand how great a diminution of population results from too little rain. Even the best maps, however, cannot explain many of the most interesting responses of man to his geographical environment, and for these we must rely on the accounts of travelers, on tables of statistics, and on many other sources.

**Map Projections.**—The fundamental consideration in any map of a fairly large area is the projection, that is, the method by which a curved surface shall be represented as flat. The curved surface can-



A. Stereographic. B. Mercator. C. Conical.

FIG. 9.—Types of Map Projections.

not possibly be made flat, as is easily seen when one tries to flatten out an orange skin without breaking it into bits. This has led to many attempts to represent the earth's surface with its meridians and parallels as accurately as possible. These all fail in one or another of the following respects: (1) the shapes of the regions represented are wrong; (2) the areas are wrong; (3) the distances are wrong. Examples of three types of projection are given in Fig. 9. The first of these is the stereographic projection, which is sometimes used for hemispheres. The sheet on which the map is to be drawn touches the globe at a point on the equator. From a point directly opposite this and also on the equator straight lines are drawn through points in the hemisphere next to the map sheet and are prolonged to the sheet itself. As a matter of fact the parallels and meridians for this projection, or any other, are drawn by geometrical principles so that actual juxtaposition of the map sheet and the globe is not necessary.

The central part of a stereographic projection is in true proportion, but on the edges the distances are doubled.

In the Mercator projection a cylinder is supposed to be wrapped around the globe touching it everywhere at the equator. Lines are drawn from the center of the globe to the cylinder through the points which it is desired to locate. When such a cylinder is cut open the whole earth appears as a single map with no breaks between the hemispheres. Both meridians and parallels are straight lines. Hence a given point of the compass is always in the same direction on all parts of the map, which is not true where the meridians or parallels are curved. Moreover, the parts of the map near the equator show the earth's features without distortion and with the correct relative areas. These advantages are offset by the fact that on a Mercator projection the poles cannot possibly be represented, and high latitudes are so extremely exaggerated that they are usually omitted or arbitrarily reduced in size. Moreover, even in low latitudes the distances and areas become exaggerated as soon as one gets much away from the equator.

The conical projection is made by placing a conical map sheet so that it touches the earth on the circle of latitude passing through the center of the map. Lines are drawn from the center of the earth to the cone. When the cone is opened the meridians are found to be straight lines and the parallels are curves. The parts of such a map near the central parallel show no distortion or exaggeration. Maps of small areas are usually made on the conical projection, while for larger areas, such as countries or continents, it is common to employ a modified conical projection made by combining the conical projections for a series of parallels of latitude. Further information as to map projections can be gained from exercise 9 at the end of this chapter and from Fig. 18.

**The Effect of Tides.**—Let us now turn from latitude, longitude, time and maps, and discuss still another geographical condition which depends largely on the earth's rotation.

During a visit to the seashore, the tides give rise to some of the most interesting experiences. At low tide in some places great stretches of oozy mudflats invite barefooted clam-diggers to wander over them with short-handled pitchforks. Elsewhere acres upon acres of sea grass lie flat on the ground, broad sandy beaches are strewn with stranded bits of seaweed, broken shells and jellyfish; while on more rugged coasts the rocks are carpeted with seaweed. In the coves many small boats lie on their sides where they have been left by the retreating water. A smell of decay burdens the air, not wholly unpleasant, yet suggesting that all is not quite as it should be.

Then the tide turns, and the water slowly rises. After three or four hours the mudflats, grassy places, and weed-strewn rocks are covered, fishermen with their nets embark in the boats which are now afloat, bathers appear on the sandy beaches, strong currents flow up the inlets where previously the water was flowing outward. The whole appearance of the shore suggests life and activity which reaches a maximum at high tide. Then the sea seems to be brimming full, all signs of death and decay are hidden, and a strong, life-giving odor pervades the air.

**The Nature of Tides.**—The tides are great waves with a length from crest to crest equal to half the earth's circumference. As the wave approaches the shore the water encroaches more and more on the land until the crest arrives, when it is high tide. In the same way the arrival of the trough of the tidal wave brings low tide. Exactly the same thing can be seen in miniature and in an exceedingly brief time when a stone is thrown into a mud puddle. Notice how the margin of the water keeps changing its position, advancing with each wave and then retreating before the arrival of the next.

The height of the earth's tidal wave varies from 2 feet in the open ocean to 5 or 10 feet on ordinary shores and 20 or even 50 in

Fig. 10.—The Effect of Shallow Water on the Height of Waves.

funnel-shaped bays like the Bay of Fundy. This is partly because of the shape of the shore, and partly because as soon as the waves reach shallow water the velocity decreases; the crest rises and the trough sinks, making the height greater; and the front becomes so much steeper than the back that finally it may topple over. A good illustration is seen in the ordinary waves of any body of water where surf occurs. As a wave approaches the shore it can be seen to rise higher and higher, as appears in Fig. 10.

**How the Moon Causes Tides.**—The cause of tides is the attraction of the moon and of the sun. The reason why they occur at regular intervals is the rotation of the earth and the revolution of the moon around the earth. Gravitation tends to bring any two particles of matter together, and the tendency is stronger the nearer the particles. But the movements of the earth and the moon in their orbits keep the two bodies apart even though their relative distances vary continually. Nevertheless the moon's gravitation is able to distort the surface of the ocean. A water surface always places itself at right angles to the pull of gravitation. Since the moon as well as the earth exerts a gravitational pull, the surface of the ocean or of any other body of water must place itself at right angles to the combined strong pull of the earth and weak pull of the moon. But the strength and direction of the moon's gravitational pull keep changing, because the earth's rotation, as well as the moon's own revolution around the earth, introduce constant and regular variations. Suppose that the surface of a section of the ocean were a vast sheet of curved glass. The varying direction of the moon's gravitation, or more specifically the so-called horizontal component of that pull, which is the part that causes the tide, may be thought of as tipping the sheet first

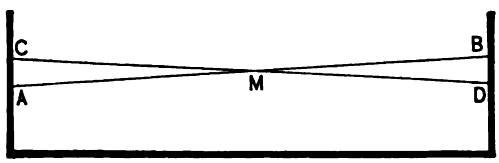



FIG. 11.—The Stationary Waves of the Tides.

*AB*, water surface tilted by moon; *CD*, same surface tilted in other direction. The entire line *CM* has high tide at once, much as in the Bay of Fundy.

one way and then another. Thus one side is raised a little while the opposite side is depressed and the central portions remain stationary. A complicated series of warpings like this is the primary cause of the tides. The size of the areas which act as units depends on the depth and configuration of the oceans. Moreover, when a so-called "stationary" wave of the kind here described has once been started it progresses outward like any other wave. The result is an extremely complicated series of tidal waves moving in all directions according to the part of the ocean which one happens to observe. Often a tide lags many hours behind the condition of the moon which caused it, and in deep bays there may even be two tides at the same time. For example, as a tidal wave progresses up Chesapeake Bay from Old Point Comfort the shallowness of the bay hinders it so much that by the time it reaches the head of the bay north of Baltimore, a second tide has entered the lower part of the bay.

**How the Sun Modifies the Tides.**—The sun causes tides like those of the moon, but in most places not so high. The usual way in which they become apparent is by increasing or decreasing the lunar tides, as appears in Figs. 12 and 13. When moon, earth, and sun are in a straight line at full moon or new moon (Fig. 12) the two tides combine so that the high tides are higher than usual and the low tides lower. These are *spring* tides. When the sun and moon are

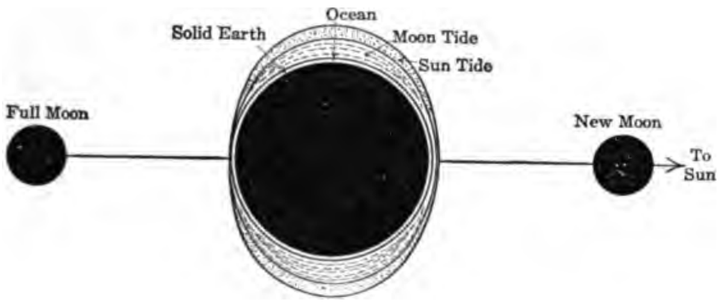



FIG. 12.—The Cause of Spring Tides. Moon and Sun Act Together.

at right angles to one another as seen from the earth (Fig. 13), they partially counteract one another so that *neap* tides neither rise so high nor fall so low as ordinary tides. In Figs. 12 and 13 it should

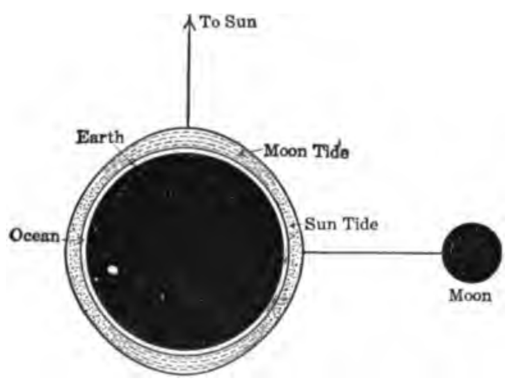



FIG. 13.—The Cause of Neap Tides. Moon and Sun Act at Right Angles.

be noted that the high tides are shown 90 degrees from the sun or moon which cause them, thus allowing for a certain lag which is usually in evidence. At ports where the harbor bars are just passable at high tide, a ship may have to wait some days if it happens to arrive at neap tide. The exact time of occurrence of either spring or neap tides varies from place to place, and in some regions may be as much as five days before or after the combination of lunar and solar activity which causes it.

**The Construction of Tide Tables.**—The chief practical application of our knowledge of how the moon and sun influence tides lies in the construction of tide and current tables. These depend not only on the relative positions of the sun and moon but on the variations in the height of these bodies above the horizon at noon in different seasons. These cause such complex relations that they require laborious calculations which are sometimes performed by means of mechanical devices; these sum up all the different effects and determine for years in advance how high the normal tide will be in any given place at any given time. The tides at any given place can only be predicted after observations have been made for at least a month, and they have to be separately computed for each port. The tides at nearby places can be roughly deduced from those at the principal ports. The alterations in the usual course of the tides because of storms and winds, however, cannot readily be predicted. At London, for example, a storm with east winds has been known to make the tide five feet higher than was predicted.

**How Tides Improve Harbors.**—Tides have an important effect upon harbors. Many ship channels such as those of New York, Boston, and Liverpool are kept from silting up by the tidal currents which scour them out daily. In many cases where it has not been worth while to dredge channels the tide enables ships to enter harbors which would otherwise be inaccessible. Off the mouth of most rivers there is a narrow zone where the sediment brought by the river is largely deposited, and forms bars. The depth over the bar is just enough to allow the water from the river to pass over it at all times. Where there are tides, the depth at low water is the same as it would be at all times if there were no tides, while at high water the depth is correspondingly greater. Thus harbors like Bangkok in Siam, and Liverpool in its natural state, which would not be deep enough if there were no tides, admit ocean liners because of the depth at high tide.

**Revolution of the Earth around the Sun.**—Thus far we have been studying the effect of the earth's rotation. Now, we are to consider the earth in its varying positions in its path around the sun. The earth not only rotates on its own axis, but revolves around the sun in an enormous and practically circular path at a distance of about 93,000,000 miles from that body. Fig. 14 represents the size that this path, or orbit, would have if the sun were the size of the little dot in the center. The earth is so small that on this scale twenty earths would be needed side by side to equal the thickness of the thinnest part of the line representing the orbit.

**How to Show the Earth's Changing Attitude toward the Sun.**—The earth's revolution around the sun would make little difference to mankind if the axis on which the earth rotates were vertical to the

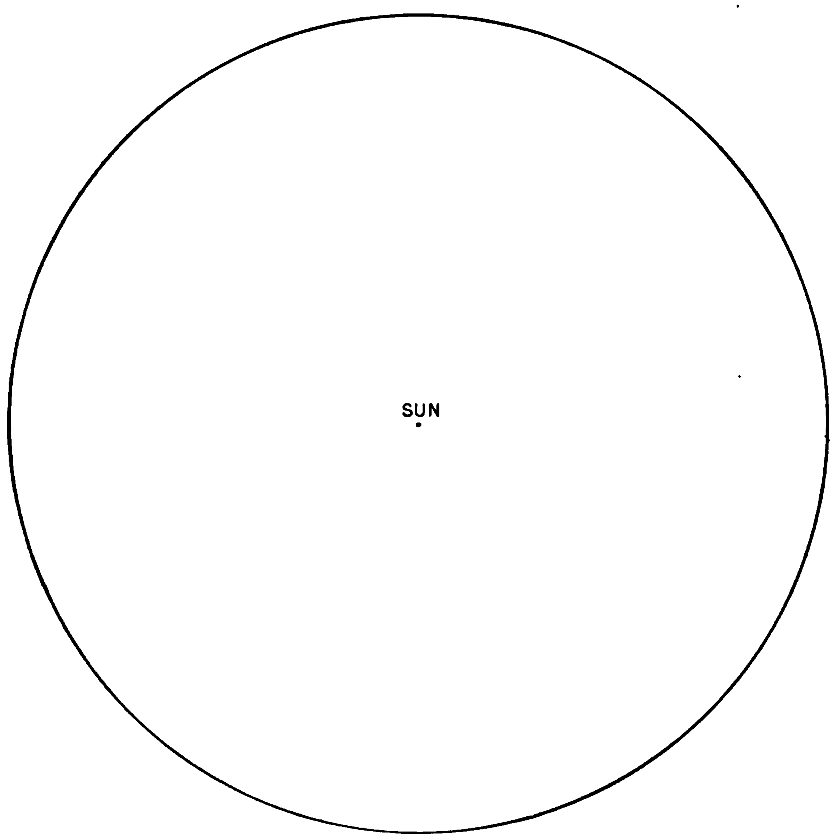



FIG. 14.—The Earth's Orbit.

plane of the orbit around the sun. As a matter of fact, however, the axis is tilted, and hence the earth's revolution causes *seasons*. The tilting of the axis may be understood from Fig. 14. Here the plane of the orbit coincides with the page. Let the earth's axis be represented by a pin around which we will imagine that there is a tiny rotating sphere representing the earth, and lying in the plane of the page. Set the pin *perpendicular* to the page at any point on the circle in Fig. 14. Now carry the pin around the circle or orbit, keeping it perpendicular to the page all the time. Wherever the pin may be, the relation of the earth to the central sun remains the same. That is, some part of the equatorial region of our imaginary earth always faces the sun, and neither pole has any special advantage. Now tip the pin so that its head points toward a certain point in the ceiling on the farther side of the room. Set the pin at various places on the circle with its head always pointing toward this same point in the ceiling, which corresponds to the North Star. On one side of the circle the northern hemisphere will incline toward the sun while the southern hemisphere will incline away from the sun. On the other side of the orbit the conditions will be reversed, for the northern hemisphere will incline away from the sun, while the southern will incline toward it.

Imagine now that you are far away in space and are looking down on the north poles of both the earth and the sun just as you look down on the page before you. The earth would seem to move around the circle in the direction opposite to the hands of a clock, or counter-clockwise. With the axis still pointing to the North Star place the pin in such a position that the regions surrounding the north pole will get as much light as possible. That will represent the true position about June 21. Now carry the pin a quarter around the circle counter-clockwise, remembering still to keep it pointing to the north star. Now it is in the proper position for September 22, and the axis is inclined neither toward nor away from the sun. Place the pin in the proper positions for December 21 and March 21. Finish the work by revolving the earth through its orbit for twelve months, stopping on your birthday, or on the day when you study this page.

**Human Habits and the Length of Daylight.**—The inclination of the earth's axis causes the sun to remain above the horizon far longer in some places and at certain seasons than at others. Hence daylight and night vary greatly in length. This influences a multitude of human habits, such as hours of rising and times of recreation. In places like Norway or Alaska, where the period of daylight is long in summer, some people become so tired and nervous from lack of sleep that they are often irritable and sometimes become insane. The long winter nights, on the other hand, bring with them a period of comparative idleness which has a bad effect on the character.

The relative length of daylight and night has also an important bearing on temperature, and thus on plants and agriculture. In high latitudes the earth and air become very cold during the long winter nights. If snow falls, practically none melts during the short days, and it may accumulate so that even the long days of summer cannot melt all of it, and hence no crops can be grown. On the other hand, where little of the summer's heat is used up in melting, the long days cause the air to become warm in spite of the low position of the sun. Hence in Siberia and Canada, grain and vegetables can be raised as far north as the Arctic Circle.

**Effect of Length of Daylight on Production of Seeds.**—Another remarkable effect of the length of daylight is seen in the production of seeds. For many species of plants, and probably for all, a certain definite duration of daylight is necessary if flowers and seeds are to be produced. Temperature, moisture, and the intensity of light all have a marked effect on the vegetative growth, that is, on the size, shape, and vigor of the stems and leaves, but not on the time of flowering. This depends almost wholly on the length of the period of light. For example, a certain kind of tobacco called Maryland Mammoth was long known to be valuable because it grows to great size, sometimes 12 to 15 feet high. It was hard to raise, however, because no matter how early it was planted it would not produce seeds except when transplanted to a greenhouse during the winter. Then it was found that plants started in the autumn and only 1 of 2 feet high would produce seeds in the winter at the same time as the great stalks that had been growing since spring. Finally experiments showed that if the tobacco were covered so that no light reached it during part of each day in summer, it would produce seed without regard to its size. In other words a healthy plant begins to produce seeds when the length of the period of daylight is reduced for a few weeks to eight or nine hours.

Other plants like the radish, for example, usually blossom only when the period of light is long. For that reason many of the common vegetables of the temperate zone will not produce seeds in the tropics, for there the daylight never lasts more than twelve hours. On the other hand, when such plants are grown in a greenhouse during the short days of winter, they can be made to blossom by subjecting them to electric light during part of the night.

Many kinds of trees that blossom early in the spring are stimulated to form flower buds by the short days of the autumn. Cold weather comes on, however, and checks their growth, but as soon as the air is sufficiently warm they blossom during the short days of spring.

All this is important to the farmer. If he wants his crops to blossom quickly without making much growth of stem and leaf, he should plant them only a little before the time when the length of the days causes the flower buds to develop. If he wants much vegetative growth, however, he must plant long before the time when the length of the day leads to flowering.

**How Daylight and Night Vary in Length.**—The cause of variations in the length of daylight and night is illustrated in Fig. 15. This represents the distribution of sunlight in the northern hemisphere during each month of the year. The proportions of the earth, sun, and orbit are far from true, but this is necessary in order to make the earth large enough. In the figure the North Pole is toward us, and the earth is revolving around the sun in the direction shown

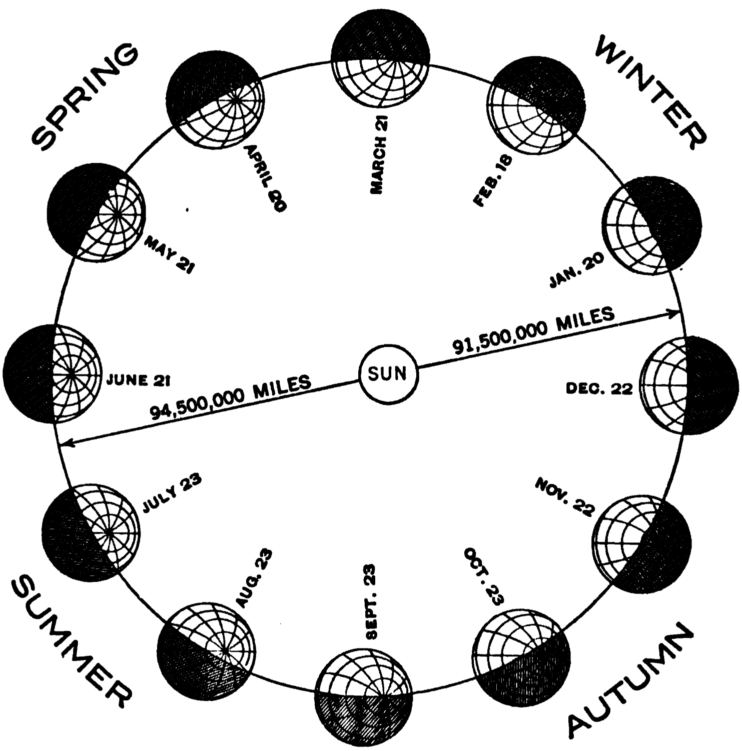



FIG. 15.—Length of Day and Night.

by the dates. It rotates in the same direction, that is, counterclockwise.

In studying Fig. 15 let us begin with the spring equinox, March 21. On that date, as appears in the uppermost of the little globes, the sunlight barely reaches the North Pole. In other words from there the sun would be seen on the horizon. There it remains throughout the twenty-four hours, swinging around the horizon through 360°, but not seeming to rise higher or sink lower. Except at the poles all parts of the earth at this date have a day and night of equal length. Therefore this date is called the spring equinox, for the name means "equal night." There is also an autumn equinox about September 22.

Look now at the diagrams for April, May, and June. At the pole the sun is now considerably above the horizon. In spite of the earth's rotation, it remains visible at all times, so that there is no night. It stands at a slowly increasing height day after day. If its path were traced in the heavens it would form a flat spiral mounting slowly upward until it reaches its highest point about June 21. Then the sun ceases to rise in the heavens, and from this point of view seems to stand still before it begins to descend again. Hence June 21 is called the *solstice*, or standing still of the sun.

Let us work out the length of the days at different latitudes and at different seasons. For instance, on July 21 five-sixths of the Arctic Circle is in the sunlight. Therefore a miner at the great bend of the Yukon would see the sun five-sixths of the time, or about twenty hours. During the night of four hours the sun would be so little below the horizon that he could see all the time. Let us see how day and night would compare about July 21 in St. Paul and Minneapolis in latitude 45°. In the July diagram in Fig. 15 approximately four and a half out of the twelve divisions into which the meridians divide the 45th parallel are in the darkness. As each division represents 30° of longitude the dark part of the circle contains about 135° and the light part 225°. As 15° of longitude equal one hour of time, the night lasts nine nours, and the day fifteen.

**The Cause of the Seasons.**—(1) *The Relative Length of Day and Night.*—The seasons play so overwhelming a part in our lives that it is interesting to understand their causes. The difference between summer and winter is due to three chief causes, each of which is dependent upon the inclination of the earth's axis. The first, but not the most important cause, is the relative length of day and night. We have already seen that when the period of sunlight is short in winter, the amount of heat given to the earth by the sun is necessarily small, but it increases as the days grow longer.

(2) *The Relative Distance Traversed by the Sun's Rays in the Atmosphere.*—The second cause of the seasons is the degree to which the sun's heat is absorbed by the atmosphere. At sunrise or sunset, even on the hottest day, one can look directly at the sun without difficulty. At noon, however, this is impossible. The reason for the contrast is that the air itself intercepts much light and heat, while the dust and moisture contained in the air intercept still more. At sunrise or sunset the rays of light reach the eye only after passing through much more air than at noon, as may be seen in Fig. 16.

Hence much less heat reaches the earth's surface when the sun is low. Since the sun never rises high in polar latitudes, such regions are always cold. Since the sun is low during part of the year in middle latitudes, and high at other times such places have pronounced seasons of warm and cool weather. Where the sun is always high

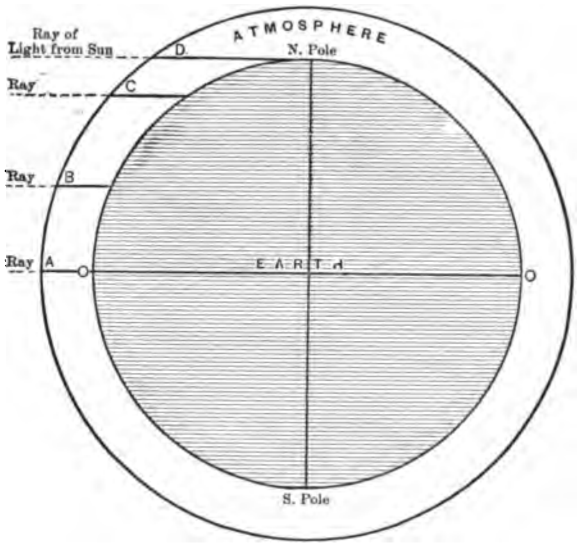



FIG. 16.—Effect of the Atmosphere on the Amount of Sunlight.

in equatorial latitudes, the weather is warm at all times and the seasons are not pronounced.

(3) *The Varying Slant of the Sun's Noonday Rays.*—A third important reason for the difference of the seasons is illustrated in Fig. 17. The middle globe shows the earth at the equinoxes, March 21 and September 23. The sun, which is far away to the right, is so placed that its rays are vertical at the equator. Between the sun and the earth has been placed a screen with two rectangular holes of the same size. The same amount of sunlight falls through each and warms a spot on the earth's surface. The spot at the equator, however, is much smaller than the one between 50° and 60° farther north. There is a difference in size because at the equator the rays fall vertically and hence cover the smallest possible amount of space, while toward the poles they fall aslant and in this particular latitude are spread over an area twice as large as at the equator. Since the amount of heat is the same in both cases, a square mile, for instance, would receive twice as much heat at the equator as a square mile in the other position. This simple

illustration shows that the sun gives most heat where its rays are vertical and least where they are most slanting.

The globes above and below in Fig. 17 show the conditions at the June and December solstices. Since the sun's rays are vertical at the Tropic of Cancer at the June solstice, the sun is nearly overhead in the United States, and a given amount of light and heat is concentrated in a relatively small area. In our winter, on the contrary, the sun is vertical at the Tropic of Capricorn, 47° south of the summer position. Therefore, in all parts of the United States the light falls at a considerable slant, a given quantity is spread over a larger area than in summer, and the heating effect is less.

*The Varying Distance of the Earth from the Sun.*—These three causes of the difference between summer and winter are slightly modified by the varying distance of the earth from the sun. But this has only a weak effect upon the relative temperature of summer and winter. In January the earth is about 3,000,000 miles nearer the sun than in July. Hence this period is called *perihelion*, which means " near the sun," while July is called *aphelion*, or " far from the sun." These conditions make the winters in the northern hemisphere slightly warmer than they would otherwise be, and the summers correspondingly cooler. In the southern hemisphere, on the other hand, the seasons instead of being tempered are made slightly more extreme. In that hemisphere the earth's varying distance from the sun causes the winters to be a little colder and the summers warmer than would otherwise be the case.

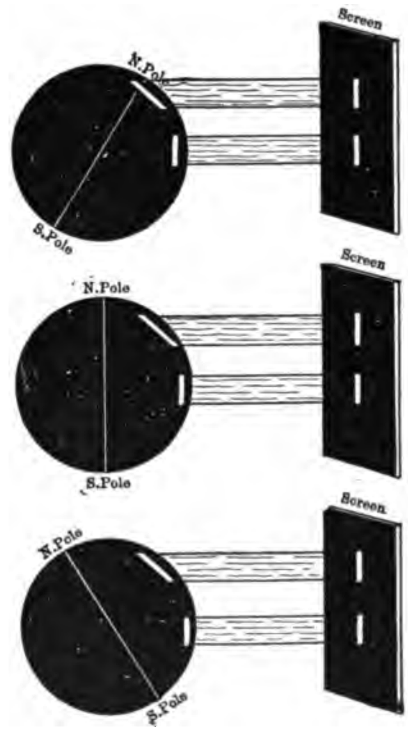


FIG. 17.—Effect of Latitude and of Tilting of the Earth's Axis on Area Warmed by a Given Amount of Sunlight.

**How Plants and Animals Respond to the Seasons.**—In the whole realm of nature few conditions of environment equal the seasons in their effect upon life. One of the most obvious results is the revival of vegetation in the spring and its return to a barren state of dormancy in winter. It is hard to realize the marvelous quality of this change until one lives where there is almost complete uniformity at all seasons as in dry deserts, polar regions, high mountains, and damp tropical forests. Equally marvelous and almost more important is the effect of the seasons upon the production of seeds, fruits, tubers, and practically all the devices by which plants store up either food or water. Without these storage organs man and many animals ranging from the bear and the squirrel to birds, insects, and worms would be unable to find food.

All sorts of grains, nuts, root crops, and fruits owe their origin primarily to the necessity of storing up food during one season so that the plant may have something upon which to make a start when a period of unfavorable weather is ended and the season of growth has come. In the parts of the torrid zone where there is plenty of moisture at all seasons, seeds and fruits are rare, and man is correspondingly handicapped in his search for food. In such places the plants grow so fast that many of them can easily reproduce themselves by mere spores such as those of the fern or by the vegetative growth of shoots as in the banyan, banana, and mangrove. In the oceans, where the contrast between one season and another is reduced to very slight proportions, no seed plants have ever been evolved. What few there are have come back to the water from the land. It is enough for the water plant to send out spores—mere unclothed cells. They do not have to endure the rigors of a long cold or dry season. It is not necessary that they make haste to grow as fast as possible in order to make the most of the time when the weather is favorable. So no little plant has to be packed away with its main organs already developed, and no store of food is needed to insure it a good start. Hence the plant life of the ocean has remained at a low level, while the stimulus of variety and especially of the seasons has caused the vegetation of the lands to be highly varied and progressive.

Among animals the effect of the seasons is as marked as among plants. The hibernation of bears, rodents, and insects, the migrations of birds and fish, the growth and shedding of winter hair or fur, and the putting on of fat at the approach of winter are all responses to the change of seasons. These and other similar changes have much importance for man. Wool, fur, lard, and bacon fat are articles which the animals produce seasonally in order to protect themselves from the winter. In warm countries sheep's wool becomes hair and the hogs are all lean.

The fact that warm-blooded animals, that is, the birds and mammals, are found almost wholly on the lands and are air breathers, even when in the water, appears to be partly due to the seasons. When animals first came out of the water and lived on the land millions of years ago, a great advantage was supposely reaped by those able to warm themselves a little and thus continue their activities in cold weather. Warm blood put a great premium on intelligence and on the development of the higher qualities such as parental care and love for offspring. The cold-blooded animals practically never care for their eggs or young. They do not need to. Among warm-blooded animals, however, if there are cold seasons the eggs must be kept warm and the young must be protected from bad weather. This was apparently one of the primary reasons why the parents took an interest in their young. Little by little the swing of the seasons selected for preservation the types of animals that had these new and higher instincts. This gave a peculiarly good chance for natural selection to preserve those whose brains were most highly developed. Thus along with the parental instinct the development of intelligence was fostered by the seasons.

All this meant that the young animals became more and more dependent upon the mothers. Hence when types that placed the young in pouches were developed, they had an advantage in the struggle for existence because the young could be protected not only from enemies but from the inclement weather. The last step was the evolution of true mammals whose helpless young are born alive. Their evolution, so far as we can tell, took place chiefly in the great continental interiors where the contrasts of the seasons are greatest, and where the rigors of winter are among the most powerful factors in eliminating many types and preserving those whose intelligence is relatively high.

In the oceans nothing of this sort has taken place, for there the almost complete uniformity from season to season has not favored the evolution of the higher types. When the higher types go back to the monotony of the oceans, as the whale has done, the lack of seasonal stimulus joins with the uniformity of the environment in other respects in causing them to lose their higher capacities. Thus the seasons have much to do with the fact that the oceans are the home of low, cold-blooded forms of animals as well as of low, spore-bearing types of plants, while the lands and especially those parts with strong seasonal contrasts, are the home of the highly developed mammals, birds, and seed-bearing plants.

**How Man Responds to the Seasons.**—Among men the influence of the seasons is no less than among plants and animals. There is scarcely an occupation which does not vary according to the seasons. With farming this is preëminently true. A farmer who has few live-stock,—and there are millions of such,—has practically nothing to do during the winter. If snow lies on the ground or the soil is frozen, time often hangs heavy on his hands. In the summer, on the other hand, in spite of the long days he is busy every moment and his work often piles up ahead of him. With students and most people who are engaged in literary and scientific pursuits quite the opposite is true. In winter, when daylight is short, they often injure their eyes by poring over books from morning till midnight. In summer when the long days are best for study so far as light is concerned, although not necessarily otherwise, they frequently spend weeks or months with little or no study. Between the farmers and the students are people upon whom the seasons have almost every degree of effect. The railroad man, the manufacturer, the banker, the carpenter, and the hardware merchant all have busy seasons and slack seasons at regular times of the year. Moreover, the character of their work varies from season to season. Health and recreation vary similarly, for people generally have the best health in the autumn, while such games as hockey and football are rarely played except at certain seasons. The difficulty is not to find examples of seasonal variations, but to find occupations or activities upon which the seasons have no effect. And all these seasonal activities depend directly or indirectly upon the differences in weather arising from the inclination of the earth's axis.

**How the Seasons have Helped to Civilize Mankind.**—Without the seasons mankind might perhaps never have become civilized. When early man began to rely on his mind instead of on physical strength, one of his first important ideas was to store up food for seasons of scarcity. So long as he lived by hunting this was relatively unimportant, but as soon as he began to practice farming he could not live unless he stored up food in summer to last him through the winter. In temperate regions with strong seasonal changes this was far more necessary than in warm regions with no real winter. Moreover, the strong contrast between the seasons stimulates him to be active and energetic not only in storing up food, but in making new inventions. In every stage of life those people are most successful who plan intelligently for the future which lies months or even years ahead of them. The inclination of the earth's axis and the resultant seasons have been one of the chief incentives to this kind of foresight.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. A. On a globe follow your meridian southward until you are in a south latitude equal to your home latitude. How many degrees of longitude are you from South America, and how many miles? How does the time there compare with that at your own home and at Greenwich?

B. Find a place half way around the world in your own latitude. Express the location of this place in latitude and longitude.

C. Express the exact location of your antipodes in terms of latitude and longitude, and find the place on the globe. How far and in what direction is this place from the nearest land? What is the hour of the day there while you are working out this exercise?

2. Locate the following points in respect to some country, island, or body of water:

A. The place having the lowest latitude and longitude.

B. The lowest latitude and the greatest longitude.

C. The highest south latitude and least longitude.

D. All the places having a latitude of 45° and a longitude of 45°. What is their time when it is noon at Greenwich?

3. A. On March 22 a sea captain observes the noonday sun 55° south of his zenith. What is his latitude?

B. On June 21, what is the latitude of an observer if the noonday sun is seen 10° south of the zenith? If it is seen 10° north of the zenith? 47° north?

C. In what harbor is a ship located if on December 22 the captain observes the noonday sun 75° south of the zenith, and notes that the chronometer agrees with the local time.

D. What is the location of a vessel whose chronometer reads 9.40 A.M. at local noon, and whose captain observes the noonday sun 43° south of his zenith on September 22?

4. A. Pittsburg, with a latitude of 40° 28′, and Charleston, South Carolina, with a latitude of 32° 48′, both lie on the 80° meridian. What is the distance in miles between the two cities?

B. Enumerate the countries you would cross in following your parallel eastward around the world.

C. Follow eastward the parallel in the southern hemisphere corresponding to your own in the northern, and list the countries that are crossed.

D. Similarly follow your meridian starting southward and list the countries that would be crossed in passing around the world.

5. How is it that an account of the last shots in the Great War was published in the morning papers of San Francisco although the firing did not stop till 11 A.M. of that day?

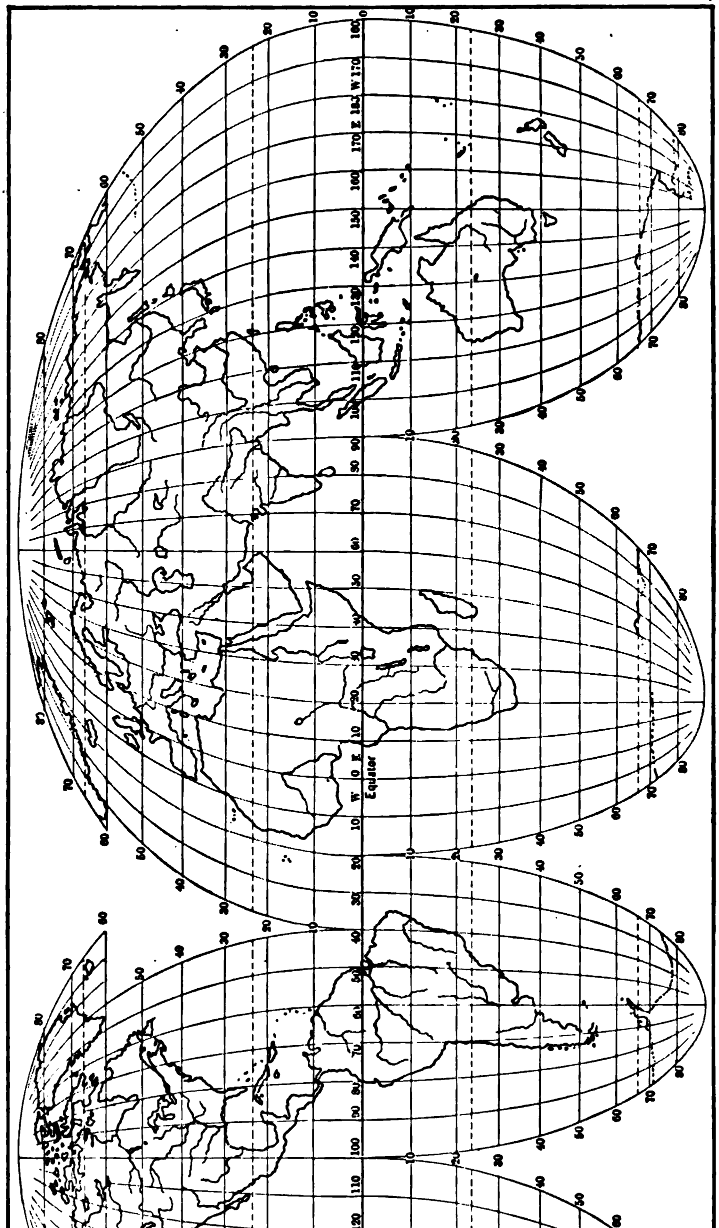
6. What kind of tides would there be in New England if on the full of the moon a vigorous northeast storm were in progress? Explain.

7. Give an illustration from your own observation or experience of the influence of seasons upon (1) food, (2) clothing, (3) shelter, and as many as possible of the other "human responses" listed in the last column of Fig. 1.

8. Why should southern New England favor the "daylight-saving plan" while northern New England prefers that clocks and watches should use the same standard the year round?

9. *Map Projections.*—One of the most important features of the map is the projection, i. e., the method of representing the rounded surface of a globe on a flat page. Different projections are used for different purposes. In order to realize how projections vary, work out the following exercises:

A. In this book or in an atlas, find maps on the following projections: (*a*) Mercator; (*b*) stereographic (or any projection showing two hemispheres separately); (*c*) homalographic (or any projection showing the whole world in a single ellipse); (*d*) conical (the type usually employed for maps of a continent or small area).




*Courtesy of J. P. Goode and the Chicago University Press.*

Fig. 18.—Goode's Homalographic Projection.

B. Trace the form of each of the following regions according to each projection: (*a*) Greenland; (*b*) India; (*c*) Australia; (*d*) Alaska. In each case compare your tracings with a globe and determine which projection gives the truer idea of the real shape. Determine which projection causes the greater departure from the truth in (*a*) area; (*b*) shape.

C. In Fig. 91 the number of cattle in India is about 60 per square mile, while in Germany it is 100. Explain why India is so much blacker. A great many maps in this book employ the Mercator projection where some other would be better. This is because these maps were taken from other sources and it has not been feasible to redraw them.

D. Fig. 18 is a map of the world on a new projection, which in many respects is better than those commonly in use. Refer to your tracings in exercise B, or else employ any other test, such as is applied in exercise C, and find out in what respects this newer projection is advantageous. State clearly the advantages and disadvantages under the following heads:

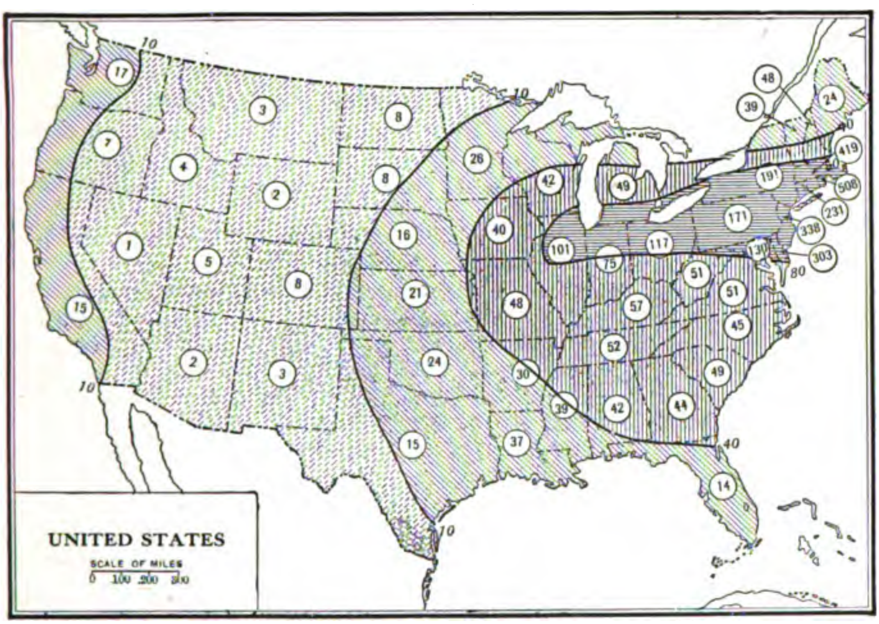



FIG. 19.—Density of Population in the United States, 1910.

(*a*) for giving an idea of the relative size of land and oceans; (*b*) for tracing ocean routes; (*c*) for gaining an idea of the shape of the continents.

E. Study a map of the regions around the North Pole. Placing a piece of tracing paper over the map, mark the North Pole and two meridians of longitude, then draw the direct route going north from Norway, from Iceland, from North Greenland, and from Nova Zembla. Draw an east-west line, i.e., a parallel of latitude, through the northern point of Greenland. Compare the polar map with the globe, and determine the accuracy of the polar projection in comparison with the four projections mentioned under A. Write a statement of the characteristics of each of the five projections in the following respects: (*a*) direction of a north and south line in different parts of the map; (*b*) direction of an east and west line; (*c*) location of the north pole.

10. *Great Circle Sailing*. Steamships practically never follow lines of latitude or longitude. Moreover, they do not go in what seem to be the shortest courses on the map but follow "great circles," that is, circles whose centers coincide with the center of the earth. Find out why this is so by taking a globe and measuring with a string the shortest route from Seattle to Yokahama. Locate three intermediate points on this route by latitude and longitude. Now locate these on an outline map of the world, and draw the route. Do the same for the following routes: (*a*) Santiago, Chili, to Auckland, New Zealand; (*b*) London to Panama; (*c*) Capetown to Boston. Write out your conclusions as to great circle sailing.
11. In Fig. 19 the numbers in circles show the number of inhabitants per square mile in each State in 1910. Lines have been drawn and appropriate shading has been added to distinguish the areas having the following density of population: (*a*) over 80 per square mile, (*b*) 40–80 per square mile, (*c*) 10–40 per square mile, (*d*) under 10.
    A. From the *World Almanac* or some other source, procure similar figures for 1920, and insert them on two outline maps. On one map add shading like that of Fig. 19, but let State boundaries determine the limits of each type of shading. On the other, draw smooth lines like those of Fig. 19, and then shade.
    B. Discuss the relative merits and defects of the two maps thus drawn. Which gives a truer idea and why?
    C. Compare Fig. 19 with the similar map for 1920 and describe the general nature of the changes in the distribution of population from 1910 to 1920.
12. Select some statistical topic which interests you, such as the yield of corn per acre, deaths from tuberculosis, the per capita expenses of cities, the per capita development of water power, the temperature or rainfall of a given year or month. Find the figures for this by States or cities in the *Abstract of the U. S. Census*, the *Reports of the Department of Agriculture*, the census volume entitled *Mortality Statistics*, the *Statistical Abstract of the United States*, the *World Almanac*, the Weather Review, or some other reference book. Make a map similar to the better of the two maps of density of population. Maps of this kind are one of the most valuable tools of the geographer.

# PART III

## *MAN'S RELATION TO LAND FORMS*

## CHAPTER III

### THE CONTINENTS AND MAN

**The Form of the Solid Part of the Earth.**—In the diagram of Human Geography on page 3 "location" is followed by "land forms." Hence these are the subject of the next section of this book. The greatest land forms are the great uplands known as continents between which lie the vast hollows filled with water and called oceans.

This arrangement of continents and oceans is apparently due to the fact that the earth is slowly cooling. Geologists say that the earth is steadily losing heat and therefore contracting. Since the crust is stiff it cannot shrink any more than can the shell of a nut. If we want to make a nut occupy less space, the only way is to break the shell by shoving it inward. During untold millions of years much the same thing has happened to the earth's crust. It has slowly settled downward by reason of its own weight. The parts that have fallen inward form the hollows that now contain the oceans, while the parts that have not fallen form the lands.

At first glance there seems to be no system in the distribution of the continental uplands and the oceanic hollows which have thus resulted from cooling. But look at a globe and see how the northern continents form an almost complete band near the arctic circle, and enclose the hollow of the Arctic Ocean. From this band three branches extend southward: (1) North and South America; (2) Europe and Africa; and (3) Asia, the Malay Peninsula and Australia. The Atlantic, Pacific, and Indian oceans fill the hollows between the branches while Antarctica rises where the southern continents would meet if prolonged southward.

This distribution of the lands as broad ridges between four chief oceanic hollows makes the solid part of the earth slightly tetrahedral in form. A tetrahedron is a four-sided solid (Fig. 20) resembling the tent of Fig. 21. If a hollow elastic tetrahedron were blown up until it formed a sphere except for broad ridges along the six edges, its shape would roughly correspond to that of the solid earth. If the part corresponding to the floor of the tent were at the north, the northern hollow would be filled by the Arctic Ocean, while the surrounding ridges would correspond to the ring of land formed by Asia, Europe, and northern North America, where the main mountains run nearly east and west. The crests of the three southward running ridges would correspond to the main mountain systems of the Americas, eastern Asia, and Australia which lie close to the Pacific hollow, and of Africa close to the Indian hollow. The third hollow, though occupied by the Atlantic Ocean, has few mountains parallel to its shores. Far to the south Antarctica represents the meeting place of the three continental ridges.

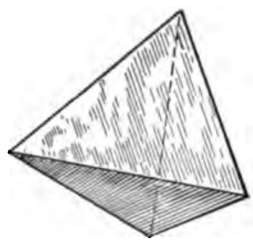


FIG. 20.—A Tetrahedron.

Because of the earth's tetrahedral shape four-fifths of the lands of the northern hemisphere lie between 30° and 60° from the equator in the latitudes where the variable climate is best for civilization. How important this is may be judged from the fact that all the great

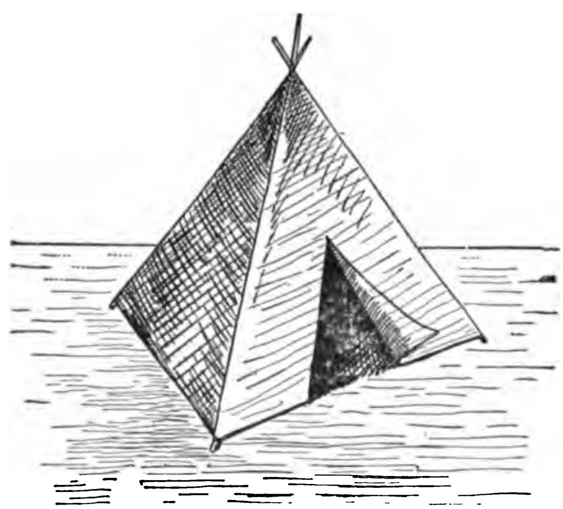


FIG. 21.—A Tetrahedral Indian Tepee.

powers are in this zone. Four-fifths of the area of the southern projections, on the other hand, lie in regions too warm and monotonous to promote human progress, and hence are the home of backward and dependent peoples.

**Where Mountain-building, Volcanoes and Earthquakes are Most Active.**—The tetrahedral form of the earth also seems to determine the location of the greatest mountain ranges. The Sierras and Rockies, the Andes, the Himalayas and Hindu Kush, the Alps, and the Pyrenees, all run more or less parallel to the edges of the earth's rough tetrahedron, with the continents flanking them on one or both sides. These mountains, because they are edges, are lines of bending and breaking along which volcanoes break out and little movements of the earth's crust keep taking place. Such movements give rise to *earthquakes*, which are most frequent where high mountains rise abruptly from oceans of great depth, as along the west coast of both Americas and along the opposite side of the Pacific Ocean from Kamchatka to New Zealand. In Figs. 22 and 23, notice how abundantly volcanoes and earthquakes are found in three tongues that extend southward on the east sides of Australia and Africa and on the west side of South America, that is, along the tetrahedral edges. Notice how another volcano and earthquake area also corresponds with a tetrahedral edge, for it extends from south-eastern Asia through the Himalayas and Asia Minor to Vesuvius and Aetna on the northern side of the Mediterranean Sea, and thence skips to Iceland with its craters and volcanic hot springs in the midst of snow and ice.

Usually earthquakes merely cause the earth to vibrate and even rumble, but do no harm. Sometimes, however, they cause cities to crumble to dust, start conflagrations which cannot be checked, and overwhelm whole provinces with terror. In our own country the one volcano that has been active in recent years, Lassen Peak, is located in the southernmost extension of the Cascade Range about 140 miles from the deep Pacific Ocean and two hundred from San Francisco, where some of the greatest recent earthquakes have taken place.

**The Continuity of the Lands.**—The same internal forces which cause earthquakes and volcanoes have heaved up the mountainous edges of the earth's rough tetrahedron so fully that aside from Antarctica the continents almost unite into one connected series. There would be no insuperable difficulty in building a railroad from the southern tip of South America to Bering Strait, under the strait by tunnel to Asia, then to Suez, and so to South Africa. A branch might run to the Atlantic coast either at Lisbon or by tunnel to England and Ireland. Another branch might run southward in Asia along the Malay Peninsula and then, with several ocean ferries, could be continued through the East Indies to Australia.

**How Plants, Animals and Man Spread from Eurasia to North America.**—The continuity of the lands has had a great effect on the distribution of plants, animals, and man. Eurasia is not only by

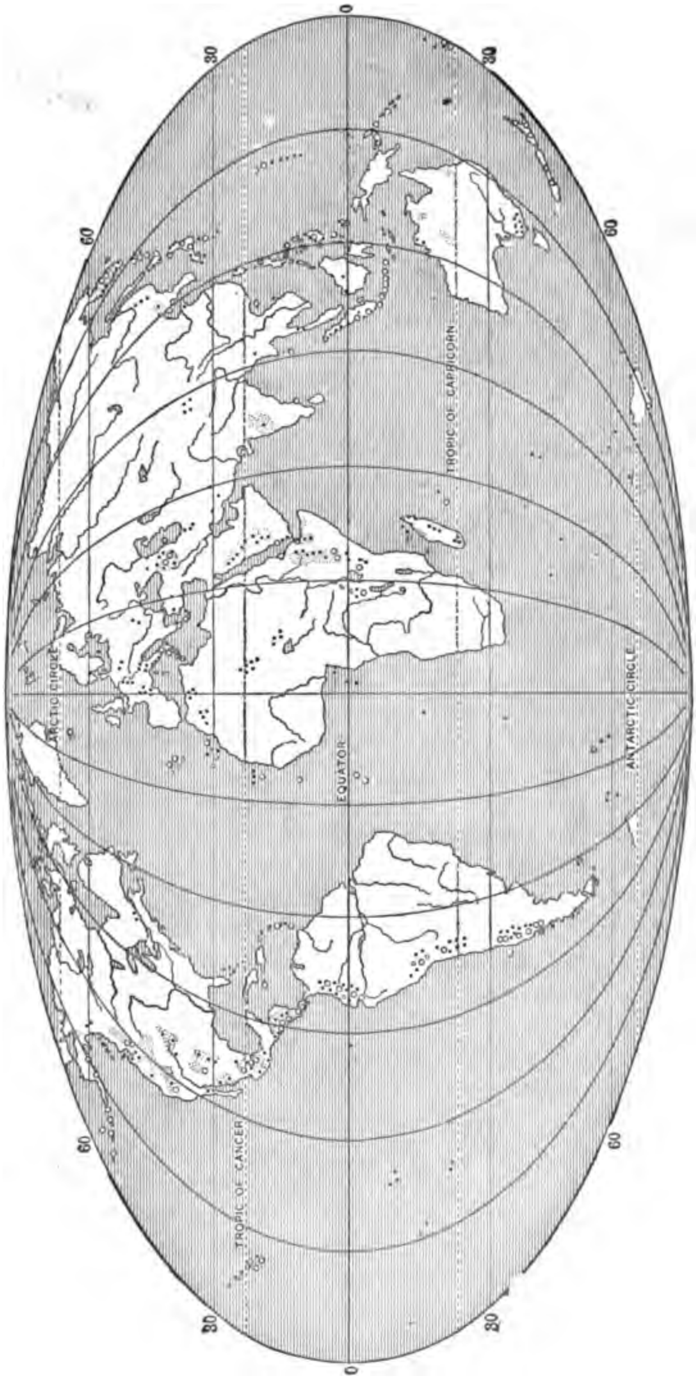



**Fig. 22.—Distribution of Volcanoes, after De Martonne.**

Open circles indicate active volcanoes. Dots indicate volcanoes recently extinct. Mollweide Projection.

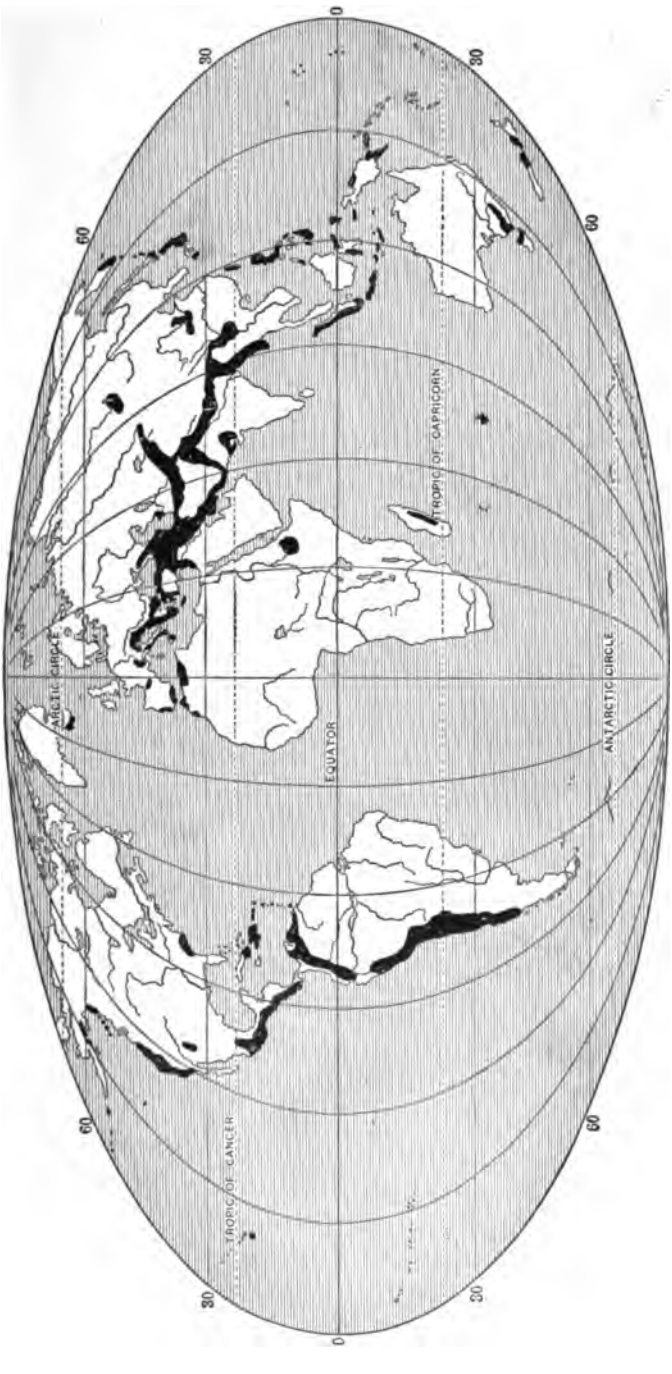



FIG. 23.—Distribution of Earthquakes, after De Martonne.

FIG. 24.—Mount Vesuvius and Naples.

FIG. 25.—A Railroad in the Andes.

**A sample of the difficulties which mountain railways often have to surmount.**

far the largest of the continents, but has been most subject to changes of altitude, climate, and size. Hence it has been the region where new forms of life have developed most rapidly during untold millions of years. The horse, ox, camel, sheep, deer and elephant; the ash, poplar, onion and wheat; and countless other animals and plants, as well as man himself, all originated there. In recent geological times a bridge of land connected Eurasia and North America where Bering Strait now lies, so that all the continents except Australia and Antarctica were united. Moreover, the climate for a while was comparatively warm even in the Far North, so that plants and animals spread from Eurasia to America. For that reason when we go to Europe or northern Asia the oaks, pines, maples, birches, and other trees have a familiar look. The wild animals, too, such as rabbits, squirrels, foxes, bear, and many others are also essentially the same. Early man seems to have followed the plants and animals to America. Hence the American Indians are more closely related to the Mongols of eastern Asia than to any other race.

**Land Connections of Africa and of South America.**—The tropical climate of Africa and South America causes their living creatures to differ greatly from those of temperate regions. Africa, however, can easily be reached by land from Asia. Hence such African animals as the elephant, lion, and horse-like zebra are closely related to the animals of Asia. Not only have animals been able to pass over from Asia to Africa, but the Indo-European, Semitic, and Negroid races have all done likewise. South America, on the contrary, can be reached by plants and animals from Asia only by way of North America and the Isthmus of Panama. Hence its animals and plants differ greatly from those of Eurasia. The little llama, for instance, is the nearest American relative of the camel. Again America has no native animal corresponding to the horse and zebra. The modern horse was introduced into both North and South America by man only after Columbus opened the way across the sea. The native Indians of South America are also so different from the native races of Asia that few resemblances can be seen comparable with those that are so marked when one compares the people of North Africa such as the Berbers and Bedouins with those of Europe and Asia.

**The Breaks between the Continents: How the Australian Break has Isolated Australia.**—Although the continuity of the lands has been of great importance in allowing plants, animals, and man to spread freely, the breaks in this continuity are no less important. One of these breaks has isolated Australia. Because of the intervening sea that continent remained unknown even longer than America. When finally explored it was found to contain strange forms

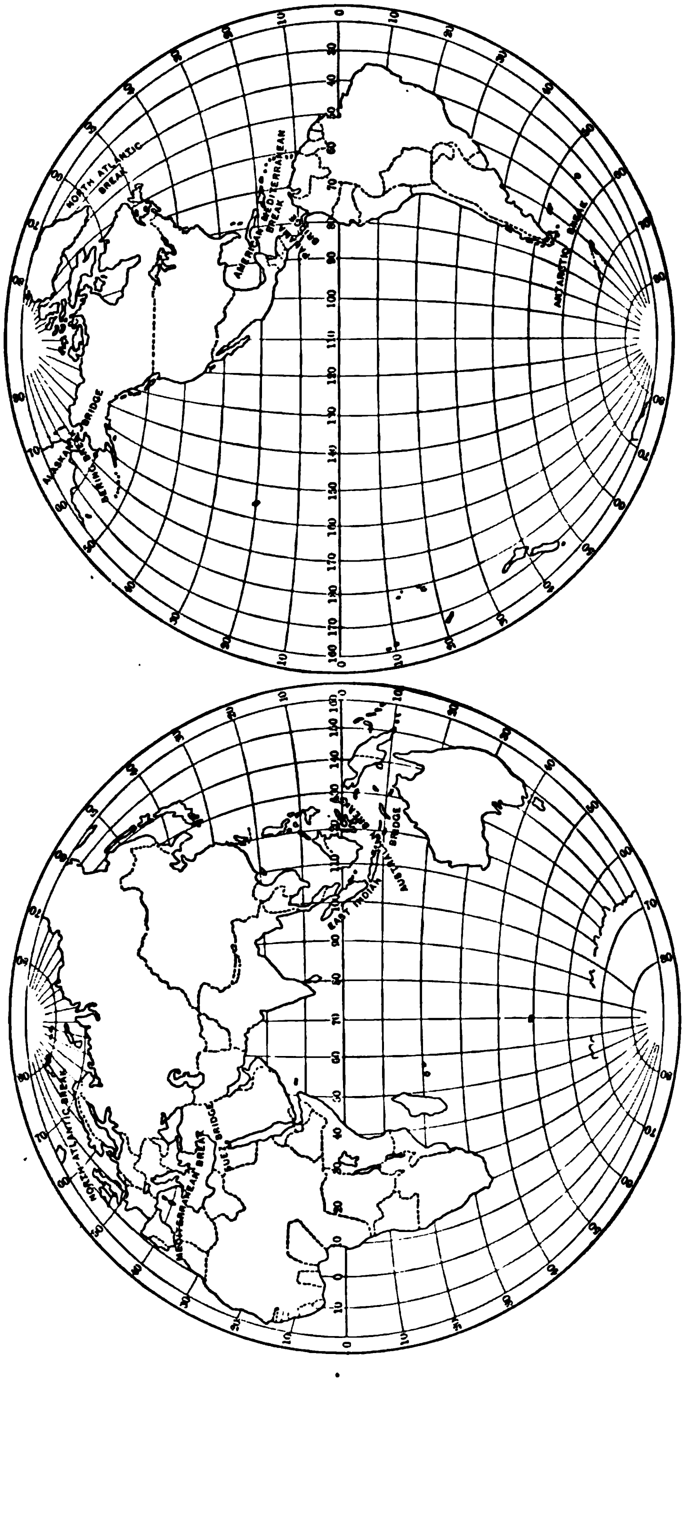



Fig. 26.—Map of the World Showing Continental Bridges and Breaks.
Lambert's Projection.

of life like the kangaroo, cassowary, cockatoo, honey-suckers, and the eucalyptus tree. The people, too, were found to have little in common with other races, and to be the most backward in the world. They had no permanent dwellings, no knowledge of farming, no ability to count more than four, and went about entirely nude. Like gorillas, they have thick skulls, small brains, thick broad noses, heavy arms, receding chins, thick necks, and hairy bodies.

The peculiarities of Australia do not mean that the continent is unfit for the forms of life found in other continents, but merely that the other forms have never had a chance to get there. This is proved by the way Eurasian animals flourish when introduced to Australia. For instance, under the influence of energetic British settlers that continent has become one of the world's great sheep-raising regions. European rabbits thrive wonderfully, and have become such a pest in pastures and farms that rabbit-proof wire fences have been built for hundreds of miles to keep them out. Their astounding increase is due to the fact that the break between Asia and Australia has kept out foxes, wolves, and other flesh-eating animals.

**How the Mediterranean Break Influences Commerce and Climate.**—The most important of the breaks between the continents begins at Gibraltar. After stretching eastward for nearly two thousand miles as the Mediterranean Sea it splits into two arms. One leads northward through the Bosphorus to the Black Sea. The other leads southward through the Red Sea to the Indian Ocean, but is interrupted by the Isthmus of Suez, which once obliged Europeans to sail around Africa to reach India. The Isthmus was such a hindrance that the Suez Canal was finally completed in 1869. Through Suez to-day passes practically all the commerce of Europe with the Far East and Australia.

In addition to all this the Mediterranean break is of great importance in its influence upon climate. Without the water evaporated from the Mediterranean Sea Italy, Greece, and the coasts of Asia Minor and Syria would be as dry and scantily populated as Persia or Arizona.

**Why Gibraltar is of Supreme Military Importance.**—Because Gibraltar guards the western entrance to the two-branched Mediterranean break in the continents, it is the most important military position in the world. In case of war the country that holds it can prevent the ships of America and all the countries of northern Europe from reaching southern France, Italy, Austria, Greece, the Balkan States, southern Russia, and Turkey. Since Britain also holds Aden, she was able during the Great War to examine the cargo of every ship entering the Red Sea or the Mediterranean, and thus to prevent ammunition or other supplies from being shipped to her enemies.

**How Constantinople Rivals Gibraltar.**—In the same way Constantinople guards the northern branch of the Mediterranean break. The country that holds it is in a position to impose enormous suffering on Rumania and Russia by throttling their trade. For generations Russia coveted Constantinople so that she might have at least one outlet to the sea through ports that are not blocked with ice for months each year. In the Great War the fate of Constantinople was one of the deciding factors. The British and French made great sacrifices in a vain attempt to open the Dardanelles. They hoped to secure a waterway whereby Russia could ship grain to her allies, while she herself received the guns and ammunition which her own factories could not supply. If they had succeeded the war might have ended much sooner and Russia might have been saved from the terrible massacres, famine, and plague which prevailed under the Bolsheviki.

**Why the North Atlantic Break is Important Climatically and Not Otherwise.**—Another place where a tetrahedral edge of the earth breaks down is between western Europe and Newfoundland, where the Atlantic Ocean projects north to the Arctic. This has no great effect on shipping, but its climatic effect is far greater than that of the Mediterranean. Because the Gulf Stream and Atlantic Drift find this outlet to the north, the waters west of England and Norway are warmed so that the winds from them give all the countries of northwestern Europe a climate adapted in the highest degree to the promotion of civilization. Without this warm branch of the ocean England and Germany would have a climate about like that of southern Alaska and the neighboring parts of British Columbia to the eastward. Not only would agriculture be less successful than now, but stimulating changes of weather from day to day because of storms would be less frequent.

West of Newfoundland and still more to the west of Greenland, the North Atlantic break ceases to be an advantage, for it permits a cold current to come from the north. The presence of cold currents on both coasts is one reason why Greenland is covered with a vast continental glacier, a genuine ice-sheet. The other break leading to the Arctic Ocean at Bering Strait is of little importance, because it is so narrow and lies so far north.

**The "American Mediterranean" Break.**—The last of the great breaks, sometimes known as the American Mediterranean, is occupied by the Caribbean Sea and the Gulf of Mexico. Like the European Mediterranean it not only exercises a strong influence upon commerce, but is highly important climatically, and is closed by an isthmus across which men have found it worth while to dig a canal at enormous expense. Since the American Mediterranean is surrounded by islands and can be entered at many points, no one place exercises a military control like that of Gibraltar or Aden. Yet in order to guard the Panama Canal the United States bought the Danish West Indies, or Virgin Islands, in 1917, and maintains an important naval station at Guantanamo in Cuba. It also has strongly fortified Panama itself, so that the Canal is now one of the world's most important military positions. The relation of the United States to Panama is strikingly like that of England to Suez. Just as England has been obliged to assume a protectorate over Egypt in order to protect Suez, so we have had to protect the Republic of Panama for the sake of our canal. As England has military centers at Gibraltar and Aden whose importance is due largely to Suez, so our stations at Guantanamo, the Virgin Islands, and Honolulu owe their chief importance to Panama.

Climatically the American Mediterranean does for us what its namesake does for Europe. Without the Caribbean Sea and the Gulf of Mexico the central United States would be far drier than now. Louisiana would be as dry as New Mexico, and even in Iowa the aridity would do much harm to farming. As things are now, much of the rainfall of the Mississippi Valley, especially in summer, comes from the Gulf of Mexico.

**The Continents: How Asia's Location Gives it Connections by Land.**--Having considered the general relations of the continents, and the way in which they are united or divided, let us consider each continent separately, paying special attention to location, size, relief, shape, and relation to the sea. To begin with Asia, its location is noteworthy because the continent is very central so far as *land* communication is concerned. Asia is the only continent that has a direct land connection with two other continents. Hence western Asia, being closely connected with Europe and Africa, has had a great influence upon both, and thus largely determined the kind of civilization which came to North America after the use of ships overcame the water barrier. How true this is we may judge from the fact that from Asia by way of Europe we have received our language, letters, and numerals. Our chief domestic animals, the horse, cow, sheep, pig, and hen are all of Asiatic origin. Wheat and barley, as well as rice and millet, were apparently brought to the other continents from Asia, so that all of our chief sources of food except corn and potatoes were derived from Asia. In later times Christianity, Judaism, and Mohammedanism all spread westward from this great continent not only into Africa but into Europe and thus into America.

**How the Size of Asia is a Handicap.**—In spite of the advantage of its position in the center of the lands Asia is seriously handicapped by its size. Because of the size vast tracts are so far from the ocean that they are deserts. The few inhabitants are very backward, not only because the dryness keeps them in hopeless poverty, but because their remoteness and the difficulties of travel keep them from coming in contact with other people whose ideas might spur them to new efforts. Many of the Khirghiz, for example, do not know the difference between Americans and Tibetans, and think a man is lying when he tells them how fast he can go on skates, which most of them have never heard of. Everywhere the size of Asia leads to great climatic extremes. Hence the disasters are on a scale unparalleled elsewhere. When drought ruins the crops in India or when tremendous floods swamp the rice fields of China gaunt famine menaces tens of millions of people.

**How the Relief of Asia Keeps Countries Apart.**—The relief of Asia is as great a handicap as the size, for Asia possesses the world's highest mountains, greatest plateaus, and deepest depressions below sea level. The main feature of Asiatic relief is a vast band of mountains and plateaus which extends from Asia Minor eastward through the Elburz Mountains across the whole of Persia and Afghanistan to a huge knot in the Pamirs northwest of India. Then the band broadens fanwise; one side, the Tian Shan, Altai, and Yablonoi ranges, striking northeast toward Bering Strait; and the other, the Himalayas and Burmese Mountains, southeast to the Malay Peninsula. How great a barrier these mountains are may be judged from the fact that though China and India are close together, no railroad connects them, and far more caravans go from China to Siberia than from China to India.

**How the Shape of Asia and its Relation to the Sea Depart from the Ideal.**—The shape of Asia is no more favorable than its relief. The continent has many great peninsulas, but the sea rarely penetrates far inland. So bulky is Asia that the interior contains an area the size and shape of the United States with every part more than 1000 miles from the sea. On the north many harbors that might otherwise be used are blocked with floating ice, and only since the invention of ice breakers and of wireless telegraphy to warn of the presence of ice has it been possible for ships to reach the mouths of the great Siberian rivers without the greatest risk. On the southwest the uplifted shores of Arabia and Persia with their smooth, narrow coastal plains are devoid of good harbors. Almost the only native sailors are a few fishers for sponges and pearls chiefly in the Persian Gulf. The only good harbor from Suez to India is at Aden. India is more favored than the countries farther west, for Bombay and Calcutta are good ports, but between them the mainland has no really good harbor. From Singapore to Kamchatka, however, the many indentations show that the land has been submerged or "drowned," so that the water has entered the valleys and surrounded many of the outlying mountain ranges such as Japan and Formosa. So there the junks of the Japanese and Chinese dot the waters with their colored sails just as the boats of the Greeks abound off the coast of Asia Minor where similar conditions prevail.

**How Europe is Favored by its Location.**—In Europe the conditions are almost the reverse of those in Asia. In the old days when men traveled only on land or close to it, Europe was completely cut off from both North and South America by the Atlantic Ocean, and could reach even Africa only with difficulty. Now in the days of *water transportation* Europe is the most centrally located of all the continents. It lies in the very center of the hemisphere which includes the greatest possible amount of land, as appears in Fig. 27. From Europe every one of the other continents except Australia can be reached by a sail of less than 3000 miles. If all the world were to agree upon a place where they could meet with the greatest convenience, western Europe would be chosen, as it has been for the central offices of the League of Nations. The continent's position is also better than that of any of its rivals in still another way. No part lies near enough to the equator to be seriously hindered by heat, while poleward the continent grows narrower so that only a small portion lies in the cold latitudes north of 60°. Even that part, as we have seen, is somewhat warmed by winds from the warm Atlantic.

**The Great Advantage of Europe's Size and Relief.**—In size and relief, as well as in position, Europe is highly fortunate. Unlike Asia, it is small enough so that except in Russia, no part is over 400 miles from the sea. The central feature of the relief is the plain that begins in England and after the interruption of the English Channel and North Sea stretches eastward across France, Belgium, Holland, and Northern Germany to Russia. This is the most important of the world's plains, agriculturally, industrially, commercially, and politically. Its fertile soil raises unusually heavy crops. Large supplies of coal and iron on its borders as well as within it encourage all sorts of manufacturing, while its level surface, navigable rivers, and good harbors stimulate commerce. The crowning advantage of the plain is the excellent climate which makes its people healthy and capable of hard work. South of the plain lie mountain ranges, some of them clad with snow even in summer, but all of small size com-

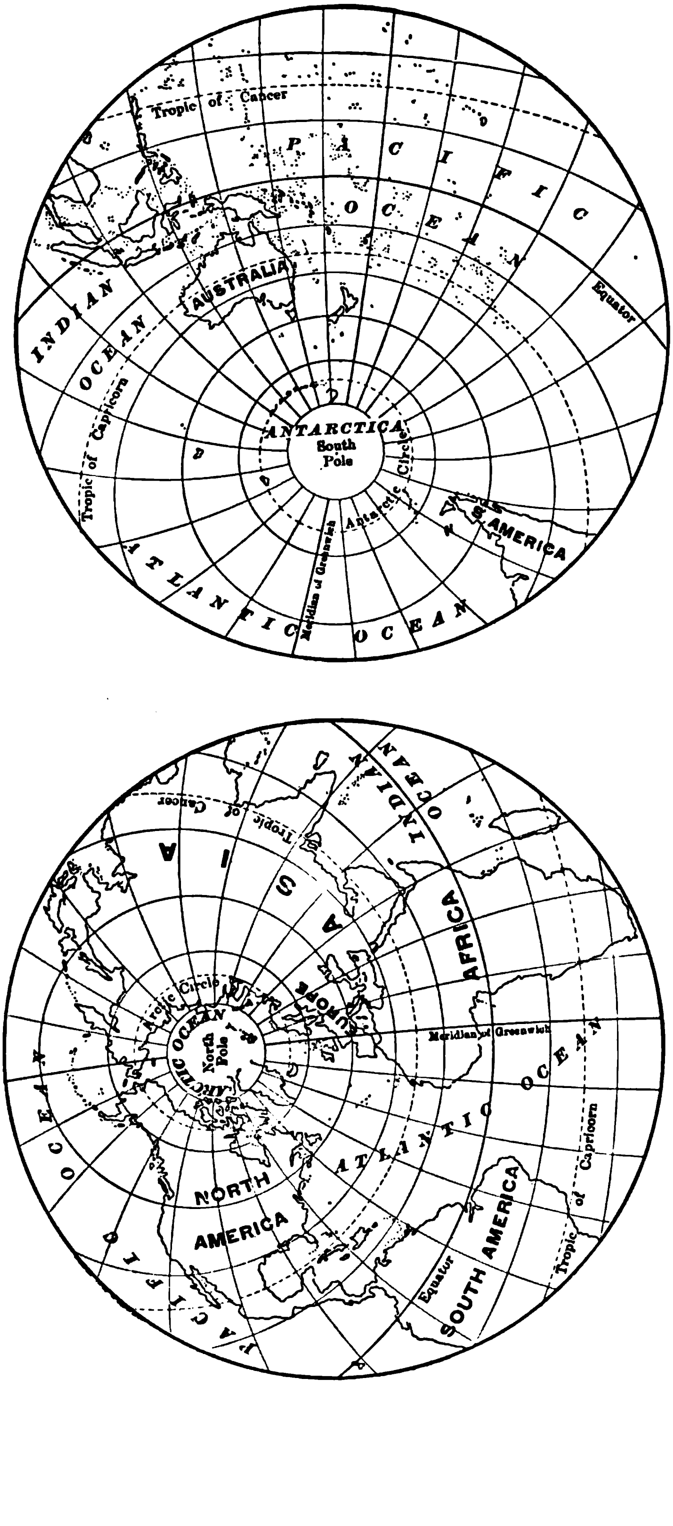



Fig. 27.—The Land and Water Hemispheres.

pared with those of Asia. In France, Austria, and Turkey they are more or less completely broken through so that communication from one side to the other is easy.

**Europe's Fortunate Shape and Relation to the Sea.**—The shape of Europe joins with the size in making its relation to the sea extraordinarily favorable. The continent is really a large peninsula of Asia, from which project many smaller peninsulas separated by extensive bays or seas. Thus the sea reaches far into the continent, permitting almost every country to have its own seacoast. Moreover, recent submergence of a large part of the coast has drowned numerous valleys, converting them into small bays that form excellent harbors like that of Liverpool. Hence nearly all the European countries have easy communication with one another by water as well as by land (Fig. 28.)

**Importance of Europe.**—In view of Europe's position, relief, and shape, together with the relation to the sea and the advantages afforded by climate and mineral resources, it is not strange that five of the seven "Great Powers" are located there. Only two, the United States and Japan, are in other continents. Nor is it strange that throughout the world the word European is almost synonymous with "civilized."

**Why North America almost Rivals Europe in Location.**—Our own continent stands next to Europe in the favorableness of its conditions. In location North America is better off than Asia, but less favored than Europe. We cannot reach Australia and the east side of Africa so easily as the Asiatics, but South America and west Africa are more accessible to us than to them. On the other hand, North America is not far from the more progressive part of Europe, while Asia borders on the less progressive part. The distance from North America to Europe became a decisive factor in the Great War. Had it been much more than 3000 miles it might have prevented the United States from putting across two million soldiers in time to help in ending the German onslaughts. Moreover, we can reach Japan, China, and other important parts of Asia much more easily than can the people of Europe. Thus the fact that one coast of America faces the Atlantic and Europe, while the other faces the Pacific and Asia, is beginning to make our location almost as favorable as that of Europe.

**How North America is Hampered by its Size and Relief.**—One of the chief disadvantages of North America is that, like Asia, it is so large that oceanic influences cannot easily reach the interior. This disadvantage is increased by the relief, for a great cordillera on the western side of the continent prevents the highly favorable influences

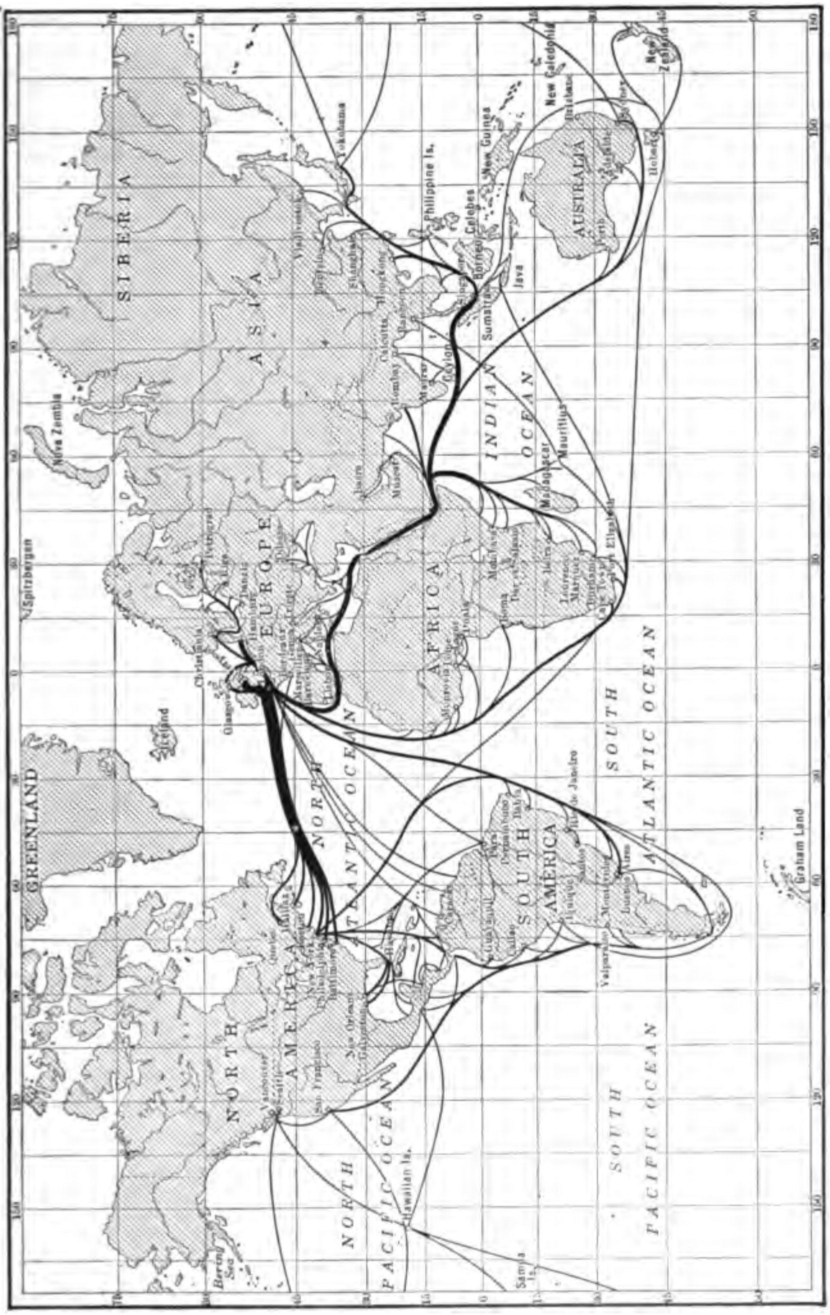



FIG. 28.—Ports and Steamer Routes of the World.
The thickness of the lines is proportional to the registered tonnage on the routes.

of the western ocean from penetrating far inland. Hence large areas are too dry for a dense population except when irrigated. This disadvantage is partly offset by a vast plain extending north and south through the center, in striking contrast with Asia's severe handicap of a central zone containing the Himalayas and the huge plateau of Tibet. Since the Appalachian Mountains can be easily crossed in several places communication from east to west as far as the Rocky Mountains is only a little harder than in Europe.

**The Intermediate Condition of North America in Shape and in Relation to the Sea.**—In proportion to its size North America has more deep arms of the sea than Asia, but less than Europe. We have already seen the value of the Gulf of Mexico and the Caribbean Sea in their effect on climate. Their effect on commerce is also important as is evident from the presence of such ports as New Orleans, or Galveston, where the outward shipments, chiefly cotton, are greater in value than those of any other American port except New York. From the standpoint of commerce the Great Lakes correspond in value to the Baltic Sea, which occupies a corresponding position in Europe. The fact that they extend from east to west along the line of greatest movement in a part of the continent where the favorable soil and climate would cause the population to be dense even if they did not exist, gives them an importance greater than that of the Gulf of Mexico. In this same general latitude the Gulf of Saint Lawrence and many other small arms of the sea do much to encourage commerce, especially on the Atlantic coast, but also on the Pacific. Farther north, however, the great inland waterway of Hudson Bay still remains almost unused. In spite of many projects to carry grain from western Canada to Europe by way of Hudson Bay, no important traffic has yet been established because of the ice and snow.

**How the Southern Continents are at a Disadvantage.**—The three southern continents are far less favored than the three northern. In size, to be sure, they do not suffer from the ponderousness of Asia, although the northern part of Africa expands to an unfavorable degree and contains the Sahara Desert. In other respects, however, they are severly handicapped. (1) Their location is such that most of their territory has a tropical climate which in many portions is extremely unhealthful and enervating. (2) Moreover, the parts of all three where the climate is most healthful, taper to small areas and lie so far from the other continents that the long sea voyage inevitably hampers commerce even in these days of swift steamships. (3) None of the three is particularly favored in its relief. In each case large parts of the coast are bordered by mountains so that communication with the interior is difficult. (4) In shape and in relation to the sea Africa and South America are about as unfavorable as they could be. Both have smooth outlines with no important indentations. Moreover, the coasts are generally of the unsubmerged type, so that good harbors are sadly lacking. Australia fares better in this respect, but its coasts as a whole are by no means so favorable as those of the northern continents.

**The Railroads of the Continents.**—The character of the continents is well summed up in their railroads. The most important of the continental railroads run east and west except in Africa. This is because they are designed to connect the regions of greatest progressiveness and commercial activity, and these regions are strung along east and west bands determined by climate (see Fig. 29).

**Main Railroads of North America.**—In North America nine main lines, that is, two in Canada and seven in the United States, cross the wide part of the continent, while four of minor importance follow short routes from ocean to ocean in Mexico and Central America. All these lines are obliged to run across the grain, so to speak, for they have to pass across the great Rocky Mountain system. In the arid western half of the United States they also have to cross great sparsely settled districts where local traffic is not sufficient to make a railroad pay. The profit comes from connecting the people in the well-populated region in the central and eastern parts of our country with the smaller well-populated region of the Pacific coast. This is one reason why the United States and southern Canada have a much greater number of miles of railway in proportion to the population than has Europe. The United States has about 27 miles of railroad for each 10,000 people, while such countries as Britain, Germany, France, and Austria have only 6 or 7. In these European countries, however, waterways are much more in use than in America. Moreover, the advantage of the great railway mileage of the United States is partially offset by its great area. We have only about 6 miles of railroad for every hundred square miles of country, while the chief European countries have from 10 to 20.

**Main Railroads of Europe.**—In Europe seven main railway lines extend entirely across the continent from west to east. They do not have to follow long routes across the mountains or across semi-arid areas of scanty population. Starting from the Atlantic Ocean in France or on the shores of the North Sea two reach the Balkan Peninsula through Austria-Hungary, and three reach the Black Sea by routes north of the Carpathians. Only two are left for all the rest of the great plain of Russia. These alone continue into Asia.

**Asian Railroads.**—Few railroads pass from Europe to Asia because its vast desert interior is so sparsely populated and its moun-

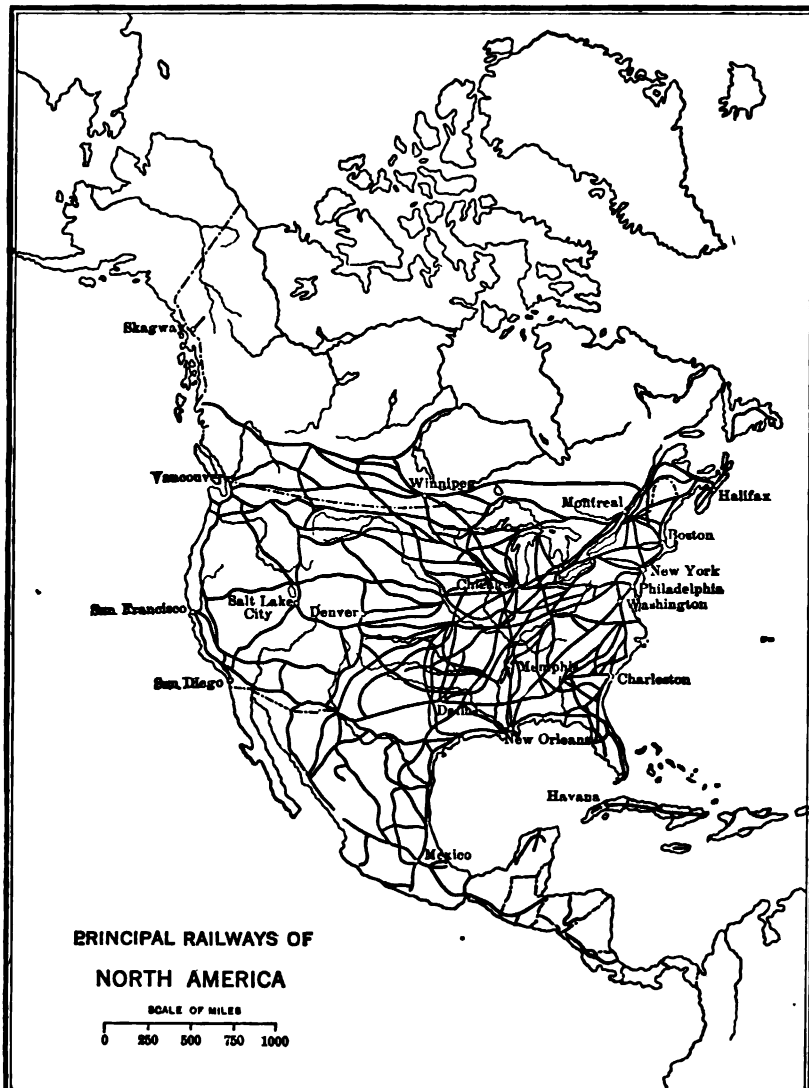



FIG. 29 A.—Railways of the World—North America.

tains are so lofty. As yet it has not been worth while to build railroads across the space which intervenes between the centers of population on the east in China and Japan, and on the west in Europe.

Nevertheless in the easily traversed Siberian plain one great trans-continental railway has been built, while in eastern Persia where the

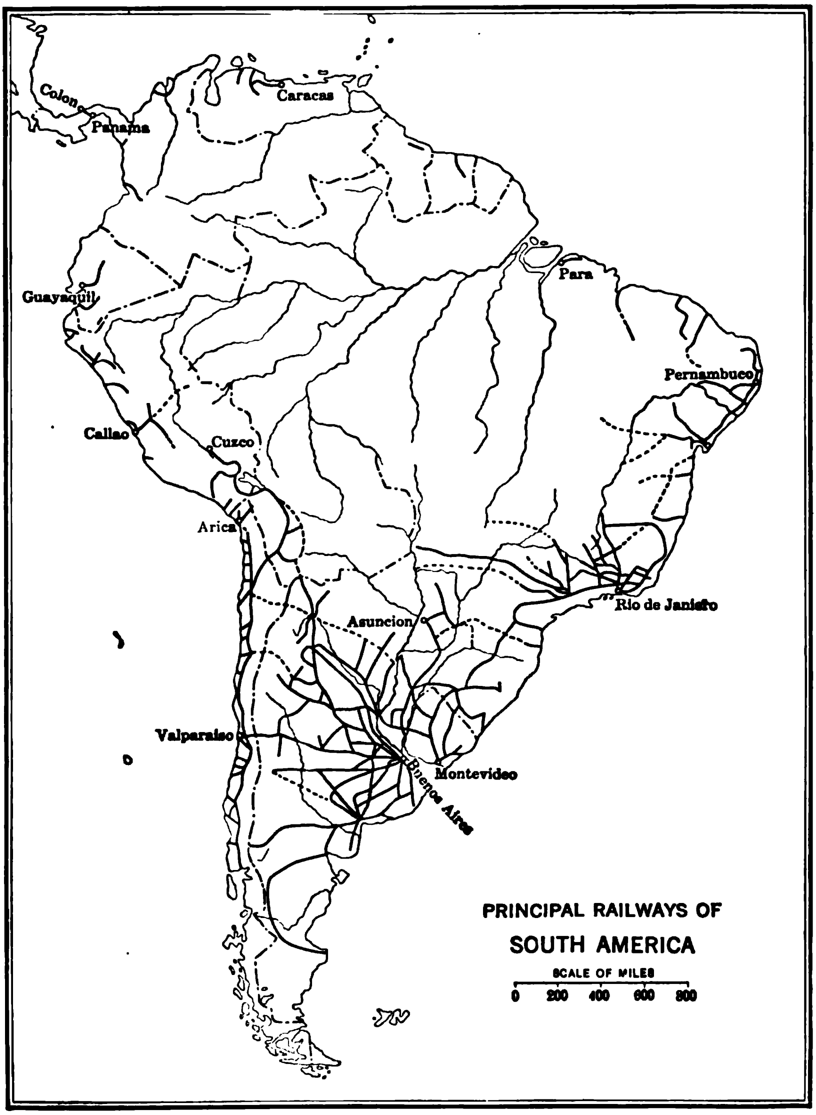



Fig. 29 B.—Railways of the World—South America.

great central mountain mass breaks down, a line practically links Russia with India. The great length of the Trans-Siberian line was a great factor in the defeat of the Russians in the Russo-Japanese war. It was also a continual hindrance in the Great War while Russia was endeavoring to receive supplies through the port of Vladivostok.

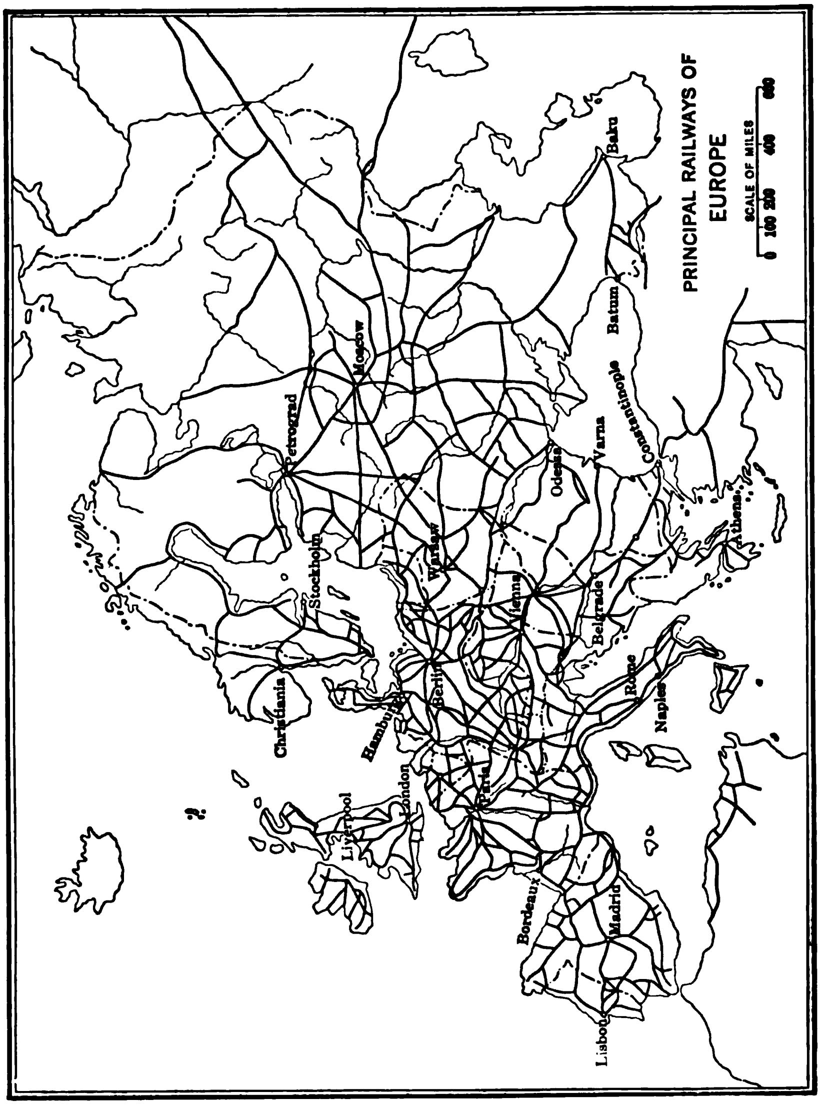



FIG. 29 C.—Railways of the World—Europe.

**African and Australian Railroads.**—In Africa no east and west transcontinental line has yet been finished. In Australia the only one was completed in 1917. It runs east and west along the soutern coast and connects the active southwestern corner of the continent with the prosperous southeastern part by crossing a barren desert over a thousand miles wide. In South America one railroad crosses

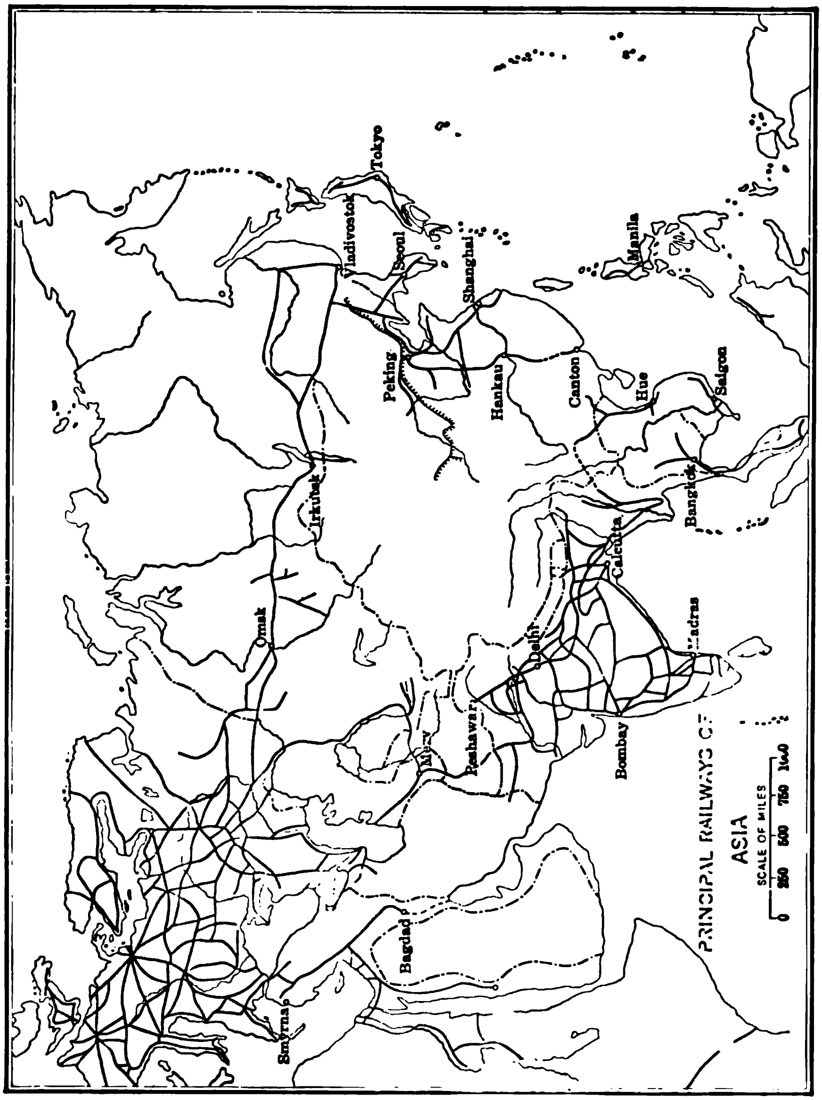



Fig. 29 D.—Railways of the World—Asia.

the narrow southern part of the continent. It surmounts the great difficulties of the Andes in order to connect the two progressive regions of Argentina and Chile, just as for similar purposes the North

American transcontinental lines surmount the Rockies and Sierras, while the Trans-Siberian road overcomes the great difficulties of enormous distance (see Fig. 29).

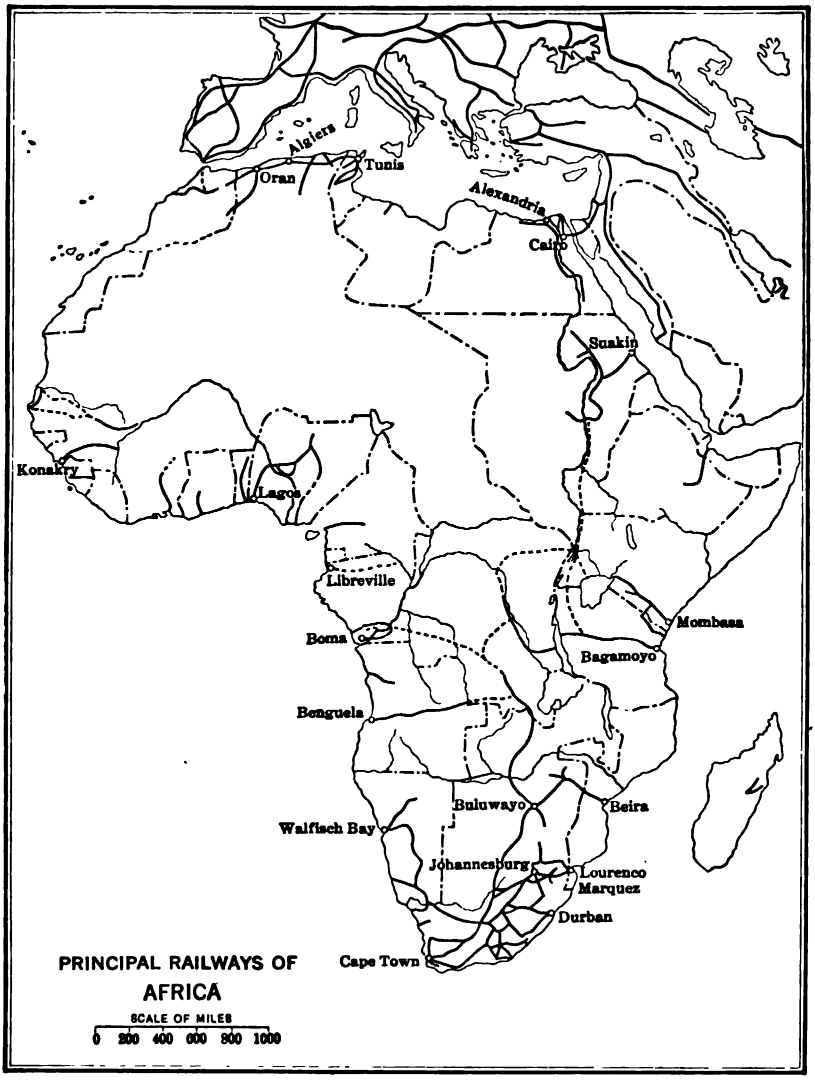



FIG. 29 E.—Railways of the World—Africa.

**North and South Railroads.**—Along north-and-south lines no great trans-continental lines have yet been finished in any of the continents except Europe. The greatest of such roads will be in Africa and

America. Their purpose, like that of the other great roads, will be to connect highly advanced centers which in their case are on opposite sides of the equator. In Africa the Cape to Cairo Railway is well

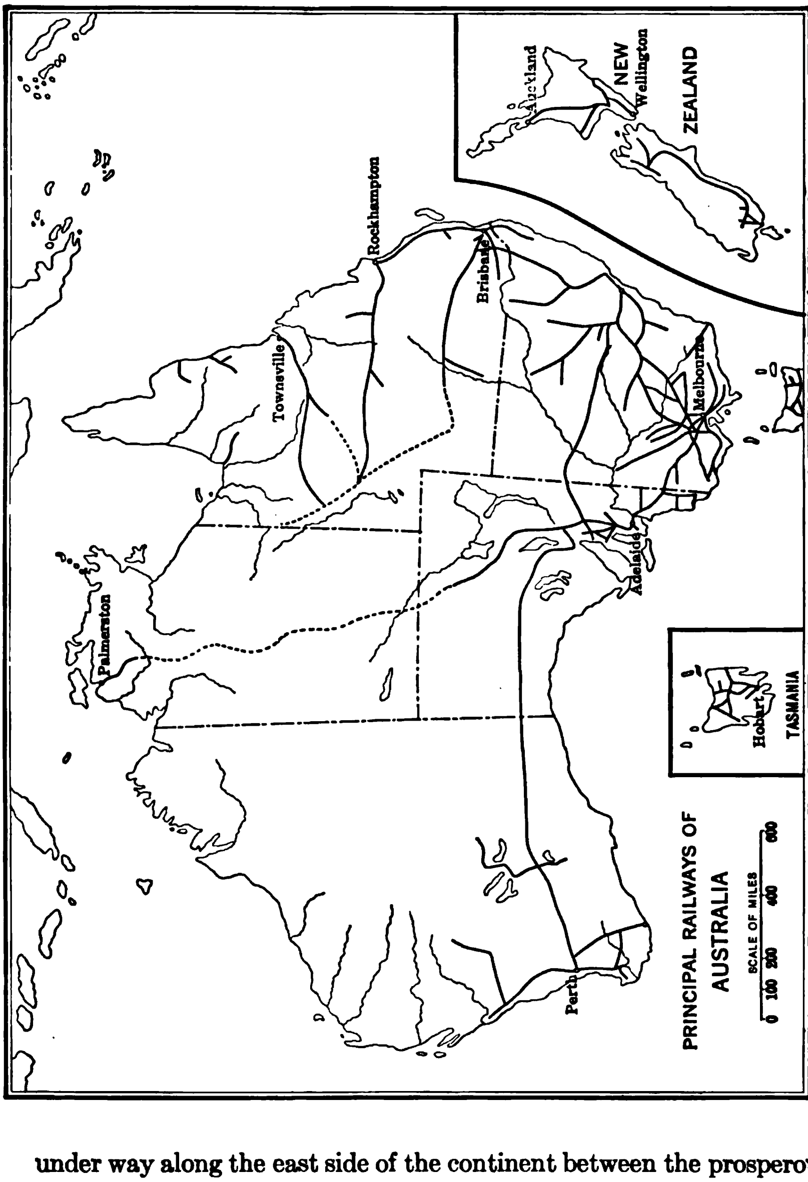



Fig. 29 F.—Railways of the World—Australia and New Zealand.

under way along the east side of the continent between the prosperous British colonies of Egypt and South Africa. It follows the Nile to the Great Lakes of Central Africa and then continues southward along the plateau. The other great north-and-south railroad will some day run from the United States through Mexico to Brazil, Argentina, and Chile, but as yet it is only a project. The increasing growth of the southern countries is rendering it more and more necessary. When it is built it can scarcely follow the difficult Andean highland, but must probably make its way along the plains. Africa has an advantage over South America in this respect, for its north-and-south railroad can follow the broad plateau and thus cross the torrid zone in a comparatively healthful region, while the American highlands are so lofty that the railroad will probably be forced to seek the densely forested, unhealthful lowland.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. On an outline map of the world and with the help of a globe and relief maps lay out the best route for a railroad from Cape Horn via Bering Strait to Cape Town with branches to Dublin and Melbourne. State where you would put tunnels and ferries. Remember that the conditions which a railroad chiefly needs in order to make it a success are (1) a dense population, (2) abundant sources of food, raw materials or manufactured goods, and (3) a level route. The conditions which hinder it most are (1) mountains, (2) deserts, (3) sparsely populated tropical forests, (4) regions with much snow and ice.

Divide your railroad into sections having a length of from one thousand to three thousand miles. For each section make a table showing the following points:

*a*. Countries through which the road passes.

*b*. Chief cities on the line.

*c*. Type of country, i.e., plains, mountains, tropical forest, tundras, deserts.

*d*. Density of population—sparse, medium, or dense.

*e*. Mode of life of people (see Chapter I).

*f*. Main type of freight on railroad. This of course depends on whether the people are farmers, manufacturers, cattle raisers, lumbermen, miners, fishermen, hunters, etc.

*g*. Commercial language.

*h*. Probable importance of this section of the railroad. Would it have much or little traffic and why?

*i*. The existing railroads that could be used as parts of the world railroad.

2. If you could reconstruct North America, what improvements would you suggest in (1) location, (2) size, (3) relief, (4) shape, and (5) relation to the sea. Draw a map of the continent embodying your suggestions.

3. Europeans discovered Iceland before the middle of the 9th century. Greenland was discovered by them during the 10th century, but Newfoundland not until the end of the 15th, and Virginia not until the 16th. Make a tracing of the Atlantic Ocean to show how these facts in the progress of discovery are connected with the distribution of land and water.

4. Find out from the Statesman's Yearbook the total tonnage that passes through the Suez and Panama Canals. State how the relative size of these figures is influenced (*a*) by the number of routes converging on the two canals,

(*b*) by the location of the canals in respect to the world's land masses. Determine how far the use of the canals depends on the proximity of the various countries.

5. The following figures show the rainfall and temperature of Denver, Indianapolis, and Philadelphia by months. Plot these on "coordinate" or "plotting" paper. Compare the three places in latitude, altitude, and distance from the sea. Point out what effect these conditions have upon the temperature and rainfall.

| | Average Monthly Temperature in ° F. | | | Average Monthly Rainfall in Inches. | | |
|---|---|---|---|---|---|---|
| | Denver. | Ind. | Phila. | Denver. | Ind. | Phila. |
| January | 29 | 28 | 32 | 0.5 | 2.8 | 3.3 |
| February | 32 | 31 | 34 | 0.5 | 2.3 | 3.4 |
| March | 39 | 40 | 40 | 0.9 | 3.8 | 3.4 |
| April | 48 | 52 | 51 | 2.0 | 3.4 | 2.9 |
| May | 57 | 63 | 62 | 2.5 | 4.0 | 3.2 |
| June | 67 | 72 | 72 | 1.4 | 4.4 | 3.2 |
| July | 72 | 76 | 76 | 1.6 | 4.2 | 4.2 |
| August | 71 | 74 | 74 | 1.4 | 3.2 | 4.5 |
| September | 63 | 67 | 68 | 0.8 | 3.3 | 3.3 |
| October | 51 | 55 | 57 | 0.9 | 2.8 | 3.0 |
| November | 39 | 42 | 45 | 0.5 | 3.7 | 3.2 |
| December | 33 | 33 | 36 | 0.7 | 3.0 | 3.0 |

## CHAPTER IV

## HUMAN ACTIVITIES IN MOUNTAINS AND PLAINS

**Civilization among the Mountains.**—The words "mountaineer," "highlander," "mountain white," and "hillsman," usually suggest people who differ from plainsmen not only in habits and modes of life, but in physique and character. The dictionary defines a mountaineer as "a person who lives in a mountainous country or district; hence a boorish person." The word highlander makes us think of bold raids such as are described in Walter Scott's novels. Mountain white suggests people of the white race who are backward and uneducated because they live in rugged and inaccessible regions. To many people hillsman brings to mind some of the wild tribes that live in the mountains north of India.

These are not the only ideas associated with these words, however, for mountaineer also makes us think of men who go to the Alps, the Rockies, the Himalayas, and other high mountains for the pleasure of climbing. Among civilized people the mention of the mountains probably calls up the idea of vacations and fine scenery more often than anything else.

Yet even so, there is a tendency to think of the people who live all the time among the mountains as different from others. Mountaineers are apt to be sturdier and manlier than the people of the plains, but even in highly civilized countries they are also likely to be less educated, more provincial, and a little behind the times. In the less civilized parts of the world the mountains are the homes of secluded people like the Tibetans, of untameable tribes like the Afghans, or of varied and warring races like those of the Balkans and the Caucasus.

**Civilization in the Plains.**—When plains are mentioned, we think of prosperous people living in flourishing villages, among fertile fields and rich farms, or else in thriving cities. The people of the farms and villages may be conservative, but not so much so as those of the mountains.

As we think of plains, we recall the growth of early civilization in the fertile plains of Egypt, Mesopotamia, and elsewhere. We realize that to-day the great nations of the world all have their densest population and greatest cities in the plains, or at least in the lowlands where the relief is gentle. Think of the world's great cities: London, Paris, Berlin, Petrograd, Vienna, Budapest, Constantinople, Bombay, Calcutta, Pekin, Tokio, Rio Janeiro, Buenos Aires, New York, Chicago, and many others. Not one of them is actually among the mountains, although some, like Rio Janeiro, Bombay, and Vienna, are close to their foot. The plains of the world, together with the lowlands where the slopes are gentle, are evidently the most desirable places for human habitation and progress.

**How Mountains are Formed.**—The study of how mountains originate and pass from youth to old age is one of the most interesting branches of geography. Here, however, we can merely call to mind a few of the chief processes. The shrinking of the earth and the bending and folding of the outer crust sometimes cause long breaks or faults extending hundreds of miles. The two sides of the fault move differently, so that one finally may stand thousands of feet higher than the other and forms a tilted *block mountain*. Such mountains are generally steep on the faulted side and more gentle on the other side, as may be seen in the Wasatch range, which has a steep fault face on the west side and a gentler slope toward the east, and in the Sierra Nevadas, where the reverse is the case. Other mountains are formed by a wavelike folding of the crust as in the Jura Mountains of France, where each ridge represents a wave. Such simple *folded mountains*, however, are rare. Most great mountain ranges consist of a crumpled mixture of folds and fault blocks, and often the blocks have been pushed in various directions or even one over another. The structure of these *complex mountains* is reflected in the irregularity of their ranges and ridges; as may be seen in the Alps, Rockies and Himalayas.

**How Mountains are Carved: Valleys.**—It would be a mistake to suppose that the form of mountains as we now see them is usually due to the faulting, folding, and crumpling that they have passed through. These processes are very slow according to human standards. Hence even while they are in progress the rivers and to a much less extent the glaciers have a chance to carve valleys and carry away enormous amounts of rock. So far has this process gone that among the Rocky Mountains only rarely is it easy to detect the original form due to movements of the earth's crust. Every little stream, and even every tiniest rivulet formed during a shower carries away part of the substance of the mountains and tends to form a valley. No matter how hard the rock may be, a river or even a small stream can eventually carve a valley thousands of feet deep and then with the help of its tributaries can widen that valley and reduce the steepness of its slopes until finally the very mountain tops melt down. Toward the end of the process the mountains become low and rounded like the White Mountains and the Adirondacks. The only parts that still stand high are those where the rock is particularly hard and resistant. Such mountains are called *residual*, and any one of them may be called a *monadnock* after a mountain of that name in southern New Hampshire.

During the early stages of their life-history, when the valleys are steep-sided and often very deep and precipitous, and when parts of the form due to the original uplift of the crust are still visible, mountains are spoken of as *young*. At such times all the influences upon civilization which we shall later describe are at their greatest, as may be seen in many parts of the Andes. When the valleys begin to widen and the slopes become less steep, and the original form due to uplift has disappeared, as has happened in the Rockies, the mountains are called *mature*. Their effect on civilization, however, is still very pronounced. Even when they become *old* with gentle slopes, wide valleys, and no great height this still remains true to a certain extent. In their final stages, however, the mountains are worn so low that they are reduced to a *peneplain*, that is almost to a plain. They then form a low rolling country with only a few monadnocks rising here and there as in the Piedmont region of the Atlantic slope, and are practically plains with all their advantages.

**How Plains are Formed.**—Plains are formed by the wearing down of any kind of region to a gentle relief, or else by the deposition of materials brought down from higher regions. Most plains are of this latter sort. Some, such as the "high plains" of Colorado and Texas or the basin plains of Utah and Nevada, have been formed by streams which flow out from the neighboring mountains. When the streams lose their velocity on reaching the lowlands, they at once begin to deposit their load of gravel and silt. They thus block their own channels and are forced to flow in new courses. Thus during the lapse of ages they flow now here and now there until finally they build almost level plains covering hundreds of thousands of square miles. Other plains, such as a large section of the central United States, were once part of the sea floor, and hence for millions of years received vast deposits of fine clay and silt brought by rivers from the lands. Then the movements of the earth's crust finally brought them almost unchanged to a level above that of the oceans.

**Plateaus and Basin Regions as Combinations of Mountains and Plains.**—Vast portions of the earth's surface, such as the plateaus of Tibet, Peru and Arizona, and the basin regions of Persia and Utah, combine the features of mountains and plains. In the plateaus a plain or region of low relief has been uplifted, and streams have cut valleys in it. Thus the valleys and their slopes have the character of mountains while the uplands have some of the characteristics of plains. On the whole, however, most plateaus are so cut up that they are more like mountains than plains, as is clearly evident in the Allegheny Plateau. In the basin regions, on the other hand, a mountainous country has been converted partly into plains, as may be seen by the way in which the peaks of half buried mountains often stick up through great plains of gravel in parts of Nevada. Often plateaus and basins are combined as in Mexico, where Mexico City is located on a high plateau, but also in a basin which is floored with a plain of soil brought down from the mountains.

It would be highly profitable to study the various kinds of mountains, plains, and plateaus in order to see how each exerts its own special influence on man. We should find that even under similar conditions of climate the mountains vary greatly in the degree to which they hamper transportation and agriculture, retard education and progress, or favor the sightseer and hunter. We should find that although most plains have relatively deep scil and dense population, and are comparatively easy to traverse, they differ greatly in these respects. Unfortunately, the limits of space oblige us to confine our study to the contrast between the life of typical mountains and typical plains. We shall talk chiefly about the mountains, however, because this is the only chapter where their influence is fully discussed. Plains are so important that they form the chief theme in the chapters on Soil and Agriculture.

**Reasons for the Contrast between Mountains and Plains.**—(1) *The Effect of Altitude.*—There are three chief reasons why the life in mountains differs from that in plains, namely, (1) altitude, (2) climate, and (3) relief. Altitude alone is relatively unimportant. People with heart trouble, to be sure, cannot live even at an altitude of 5000 feet, and most people find difficulty in breathing at altitudes of 10,000 feet or more. Nevertheless when people go to high altitudes the body soon adapts itself to the new conditions. An increase in the number of red corpuscles in the blood enables it to absorb oxygen more rapidly, and thus the rarity of the air, which is the great difficulty at high altitudes, is robbed of much of its effect. When people come down from the mountains this excess if red corpuscles makes them feel very strong, but it quickly passes away. This prompt change in the blood enables people to adapt themselves to any altitude where the climate and relief make it possible to get a living. Denver, for example, has become a great city a mile above sea level, Mexico City is half a mile higher, Quito prospers at an altitude of nearly two miles, and certain villages in the Andes and Tibet raise barley and sheep nearly three miles above the sea. In each case a high plain makes it possible for the city or village to grow up in spite of the altitude.

(2) *How the Climate Differs in Mountains and Plains.*—In the loftiest villages of the Andes and Tibet the villagers think little about the altitude, but much about the climate. This is because altitude influences climate in three main ways: (*a*) Temperature decreases with altitude. In the free air the fall is about 1° F. for 400 feet of altitude in summer and for 500 feet in winter. The fall is more marked where mountains rise steeply above a lowland as in the Alps, than in regions like the Great Plains where one can rise from sea level to Denver almost without noticing any grade. Nevertheless the average yearly temperature at Denver is about 3° lower than at Indianapolis, which lies in the same latitude but 4500 feet lower. (*b*) The greater the altitude the more variable is the temperature. The rarity of the air allows the sun's heat to pass through it readily and thus the earth's surface is quickly warmed, but the same condition also allows the earth's heat to pass away rapidly at night, so that there are great extremes. The relief also causes variability, for cool air may flow down a valley at night while warm air rises by day. (*c*) Mountains are also more cloudy and rainy than plains, for the currents of air that approach them must rise. Hence the air is cooled and its water vapor condenses into clouds and rain. On a perfectly clear day in the plains of California one can often see great banks of clouds enshrouding the crests of the Sierras only 40 miles to the east. While the dry brown grass of the plains shows that no rain has fallen for months, the dense pine forests of the mountains, and the little brooks flowing amid rich green grass or thick brakes of flourishing bushes betoken rain in plenty.

(3) *The Great Importance of Relief.*—In the rest of this chapter we shall confine ourselves largely to relief, the third of the great reasons for the contrast in the life of mountains and plains, but it must be remembered that climate and relief work together so closely that they often cannot be separated.

**The Uneven Distribution of Population in Mountain Regions and the Even Distribution in Plains: Switzerland versus Iowa.**—One of the conditions where the effect of relief alone can be most clearly seen is in the different distribution of the population among mountains and in plains. Fig. 30 is a map of Switzerland showing the density of population. Notice how irregularly the people are scattered. There is a great concentration in the northern lowland, where most of the people live, while among the mountains the inhabitants are distributed here and there without apparent order, but really along the main valleys. Contrast this with Fig. 31, a similar map of the plain of Iowa. How evenly the people are distributed!

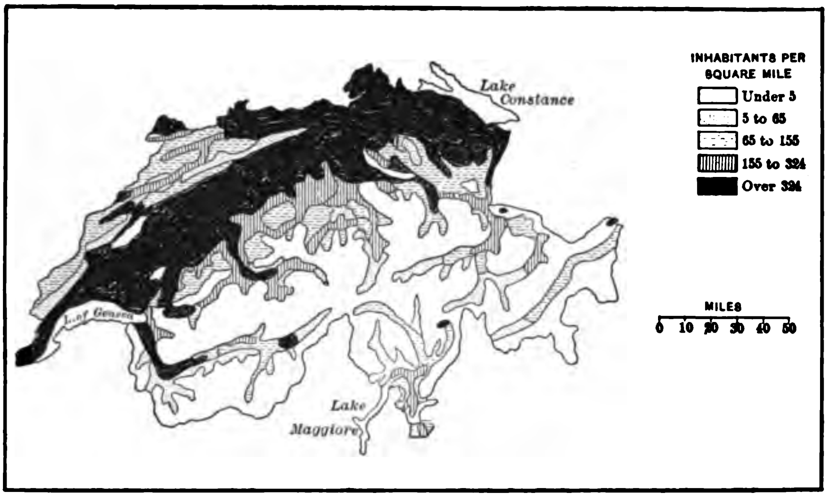



FIG. 30.—Density of Population in Switzerland.

An example of extraordinary diversity due to relief. Contrast with Fig. 31.

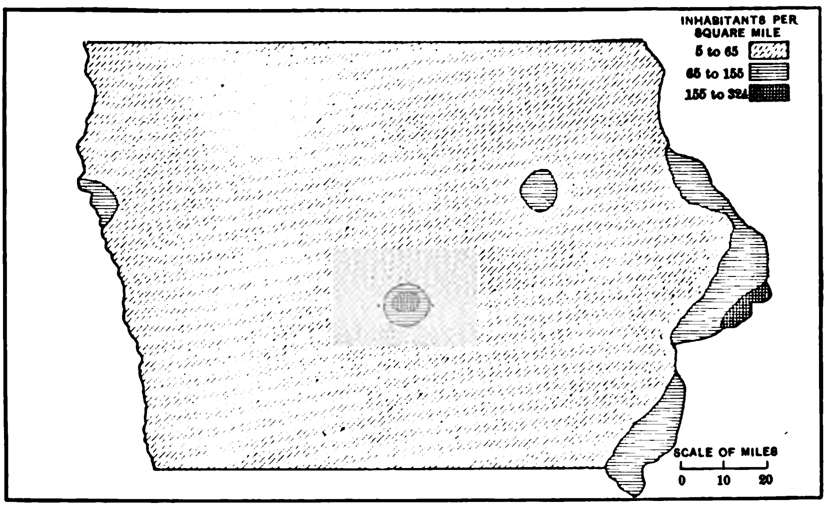



FIG. 31.—Density of Population in Iowa.

An example of extraordinarily even distribution of population in a plain, with a few dense areas due to rivers. No county in the State has a density of less than 22 per square mile, or over 200.

Practically every township of 36 square miles contains about a thousand. A few cities have grown up, but are quite evenly spaced throughout the State and not concentrated in one section, as in Switzerland. The reason is obvious: In Switzerland people cannot live in any large numbers in the rugged portions and must concentrate in the valleys; in Iowa the plain is so uniform that people can live anywhere.

**The Sparsity of Population in Mountains Compared with the Density in Plains.**—There is a strong contrast between mountains and plains in the *density* of population as well as in the distribution. This is due to the combined effects of relief and climate. In California there is a beautiful district called Alpine County. In 1890 its population numbered 667, or a little less than one for every square

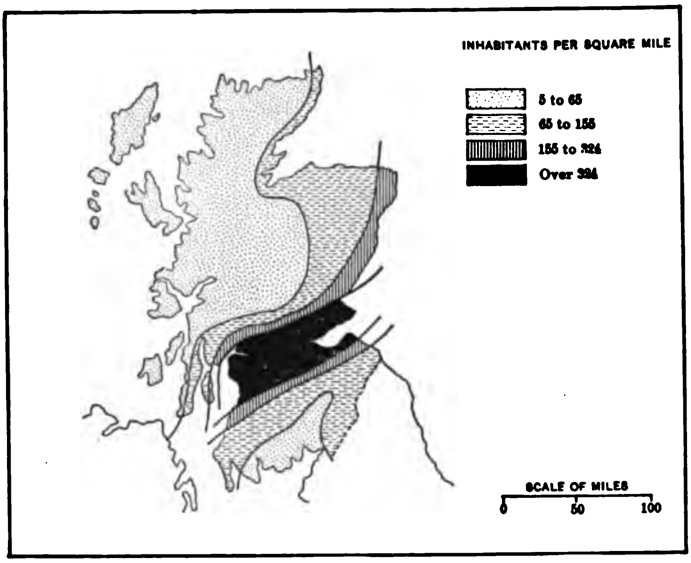



FIG. 32.—Distribution of Population in Scotland.

mile. In 1900, this had fallen to 509, in 1910 to 309, and in 1920 to 243. Some 80 miles west of Alpine County, Sacramento County, though only a little larger, contained 40,000 people in 1890, or more than 40 to the square mile, while in 1900 the population numbered 46,000, in 1910, 68,000, and in 1920, 91,000. Why should one county contain only one person in 3 square miles and show little or no prospect of containing more, while the other contains 92 people to the square mile? The answer is simply that Alpine County is one of the most mountainous parts of the United States, while Sacramento County is a smooth plain.

Such contrasts between mountains and plains occur everywhere. In India the little country of Bhutan on the rugged southern slope of the Himalayas contains only 12 people per square mile, while close at hand the level plain of Bengal has over 500. Even where the contrast between mountains and plains is less striking there are great differences in the density of the population. For instance, in Fig. 32 notice how the people of Scotland are concentrated either in the southern lowland from Glasgow to Edinburgh and Dundee, or else along the plains of the eastern coast where Aberdeen is located. The rugged highlands both in the north and south have so few people that they appear almost white on the map.

**The Advantage of Plains over Mountains in Transportation.**—We come now to a condition where the relief of the mountains is an especially heavy handicap. In mountainous regions the roads and even the railroads must go up and down hill. Everyone knows how hard it is to haul a heavy load uphill. The load not only has to be carried forward, but must be lifted against the pull of gravity. Another difficulty in a rugged country is that the roads must often wind in broad curves or go out of their way to follow valleys, so that they traverse much greater distances than are necessary on a plain. Compare the two parts of Fig. 33. The southern part with the straight railroads belongs to the level plain of southern New Jersey, while the northern part with the curved roads is in the rugged portion of that State.

The hard work and long distances on mountain roads combine to cause three other disadvantages which are not felt in plains. First, transportation is slower. For example, on the level stretch between New York and Philadelphia a fast train on the Pennsylvania Railroad travels 50 miles an hour, while on the mountainous stretch where the road climbs the Allegheny Escarpment over the Horseshoe Curve between Altoona and Johnstown the average speed is only 20 miles per hour. Second, the steeper grades cause greater wear and tear on both animals and engines. In rugged Vermont an automobile is considered " junk " after traveling half as many miles as in level Kansas. Third, the uphill work, the slow speed, and the wear and tear all increase the cost of transportation among the mountains as compared with plains. For instance an automobile that makes 16 miles on a gallon of gasoline in Nevada, can make only 6 when it climbs the Sierras into California. Moreover, the cost of making and especially of repairing roads and railroads is often ten times as much in the mountains as in the level plains.

Looking at the matter from the standpoint of plains we find that they have the following advantages: they permit transportation routes (1) to avoid hard grades, (2) to go in any direction, and to follow straight lines, (3) to form as dense a network as the inhabitants

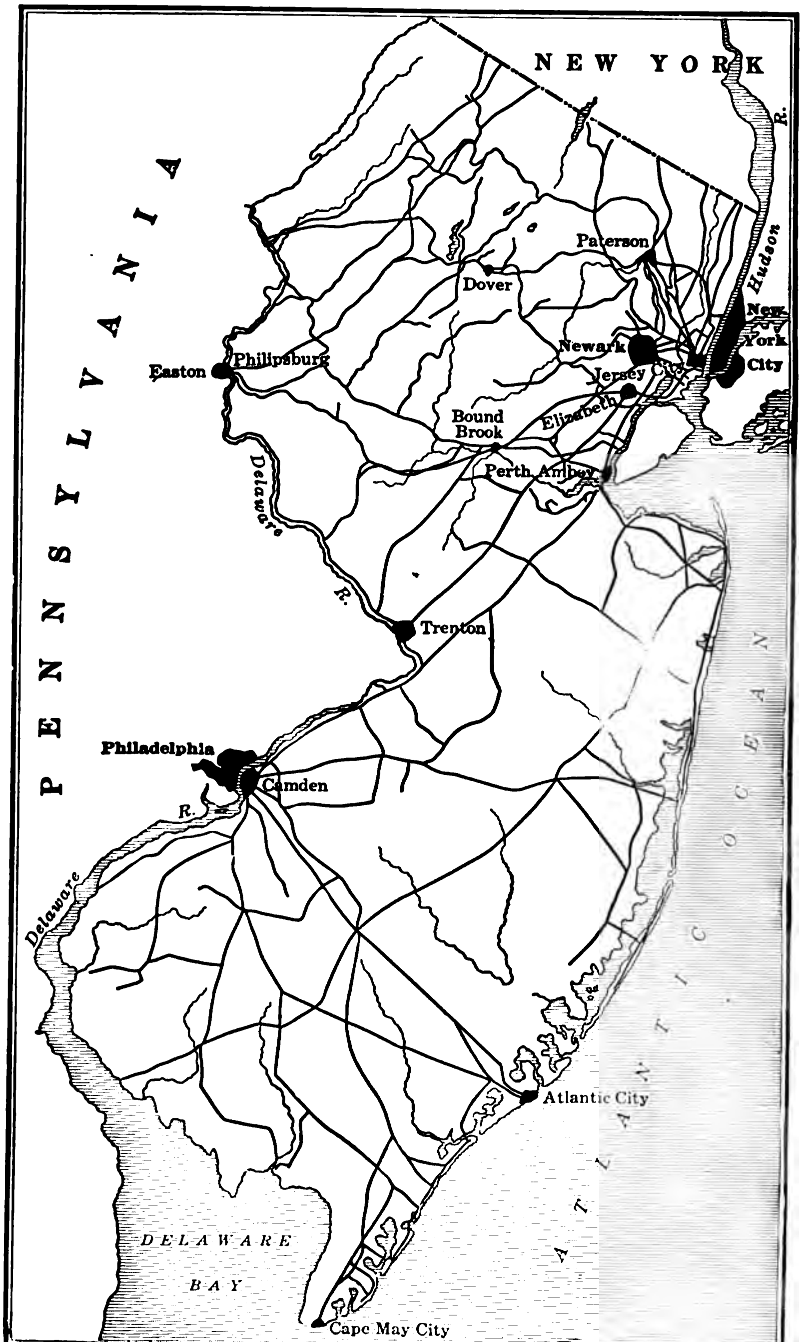



Fig. 33.—Railroad Map of New Jersey.

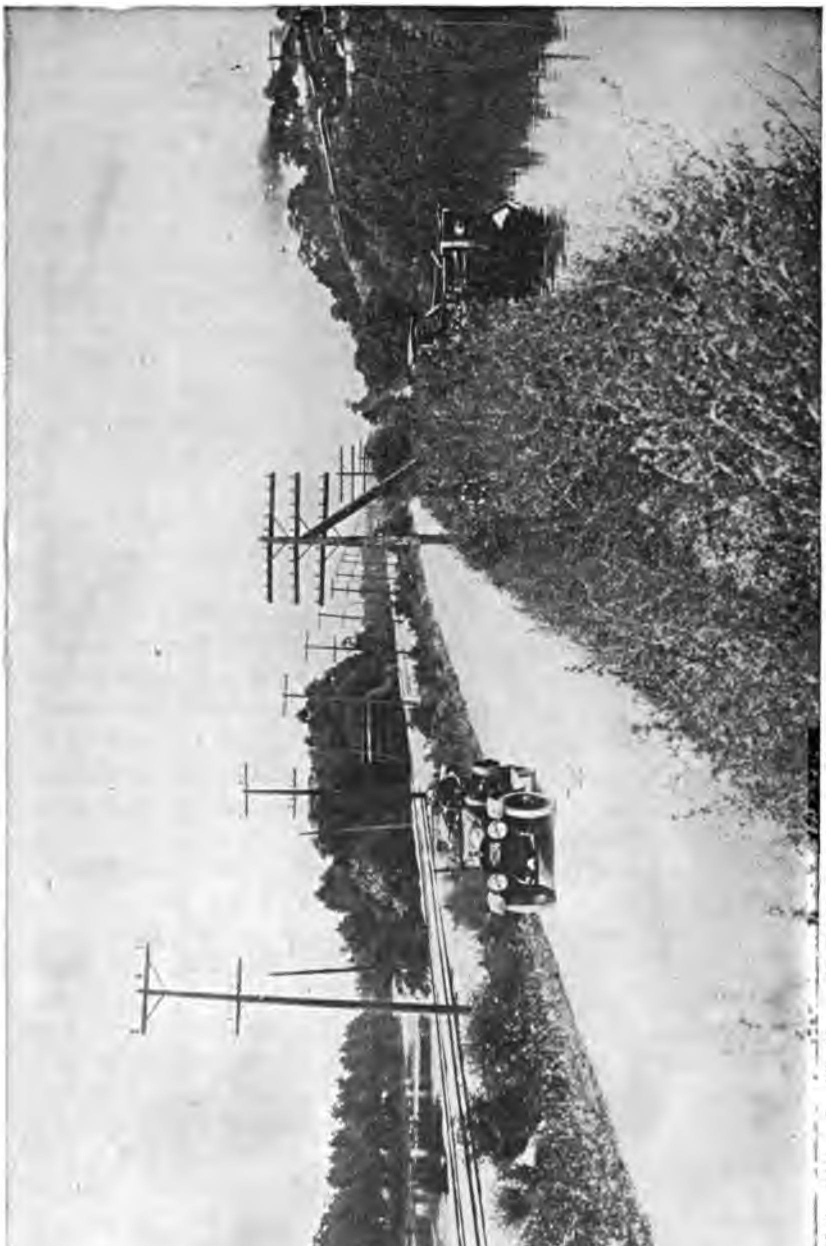
require, (4) to be adapted to rapid travel, and (5) to be built and maintained cheaply.

**Why the Means of Transportation Differ in Mountains and Plains.**—The most striking difference between the means of transportation used in mountains and plains is that in the mountains primitive methods are still used while in the plains advanced methods have made much more progress. Even in the most civilized countries like Switzerland pack trains are still common among the mountains, while in the plains of the same countries they are unknown. In plains it is possible to build numerous railroads and also trolley roads not only because the cost of construction is moderate, but because there are many people. Not only are there more plainsmen than mountaineers, but they produce and consume more per capita, and hence provide the railroads with more business. Even the airplane is far more adapted to plains than to mountains, because it requires broad level spaces in which to land.

Since railroads are less numerous in mountain regions than in plains, the mountaineers must rely upon roads and often must carry their products long distances. What is true of railroads, however, is also true of roads. In the plains they can be built easily and cheaply and there are many people among whom to divide the cost. In the mountains they are expensive and there are few people to bear the cost. Therefore many parts of the mountains have no good roads, and wagons cannot be used. Hence goods must be transported on pack animals, which can follow rough trails that require no expense for their construction. The animals that have been domesticated for this purpose vary from place to place.

This difference in the means of transportation does even more than the steep grades and the greater distances to make transportation more costly in the mountains than in the plains. For example, it costs about two cents to carry a ton of freight a mile on a level railroad. To carry a ton the same distance on the backs of horses among the mountains often costs from $1 to $5. It may pay to carry cloth long distances by such expensive methods. It rarely pays to carry cheap, heavy articles like iron. If grain were carried from Illinois to New York by this expensive method it would cost at least $20 to $30 a bushel.

**An Example of the Effect of Mountain Transportation.**—Sometimes the difficulty of transportation among the mountains leads to peculiar kinds of law-breaking. For instance, in Kentucky, Tennessee, and other places in the southern Appalachian Mountains there used to be many "moonshiners" and there are still some who distill whisky illegally. They need ready money; the corn, which is their



*From the National Magazine, Washington, D. C. By special permission.*

FIG. 31.—Five Modes of Transportation, and Two Modes of Communication.

A remarkable example of the effect of a valley.

*By courtesy of the Canadian Pacific Railway Co.*

FIG. 35.—The Winding Canadian Pacific Railroad near Field—British Columbia.

**Note the many conditions which make transportation expensive, especially the entrance to spiral tunnel under the track on the extreme right. Note also the small area flat enough for cultivation even if the climate were favorable. Contrast this with Fig. 114.**

chief crop, cannot be taken to market down in the lowlands because there are no good roads. The price at which the corn would sell would not pay a quarter of the cost of transportation.

If the same corn is made into whisky the resulting product is only one-thirtieth as bulky as the corn. The cost of transportation is thus reduced so that the mountaineer can carry his product to the lowlands and sell it at a profit. This fact has caused the mountaineers to break the law for many generations. When the government collected a tax on whisky the "moonshiners" felt that it was not right to take away their profit on the only product that they could take to the lowlands and sell for cash. When the sale of whisky was completely forbidden, the mountaineers felt that a still greater injustice was done them. Thus for many years they have broken the law because the mountains make transportation so difficult.

**Difficulties of the Farmer in Rugged Regions:** (1) *Rapid Erosion.*—The farmer in rugged regions is at a disadvantage because he lives in a region of erosion. Every rain carries away some of the soil, especially when the fields have been freshly plowed. In the Carolinas, Georgia, and other Southern States the Appalachian foothills have suffered almost irreparable harm in this way. Under the influence of unwise cultivation the soil of hundreds of farms has been gullied so that the fields are ruined. Where the slopes are fairly gentle this difficulty can be overcome by plowing so that all the furrows are horizontal and the rain water stands in them instead of running down them. This is called *contour* plowing because the furrows run horizontally like the contour lines on a map. The washing away of the soil by the rain and also by landslides and avalanches is doubly harmful for the material carried from the fields is often spread out on the valley floors and there for a time ruins other fields.

(2) *Thin Rocky Soil.*—Although more soil is actually formed in mountain regions than in plains, so much is carried away by erosion that the remaining soil is thin and rocky. Among the Himalayas, for example, the fields are so rocky that each year after they have been plowed, women go about picking up the stones and throwing them over their shoulders into baskets strapped to their backs. They have done this for centuries, yet the stones are still numerous, for new ones are plowed up or brought down by the streams.

(3) *Lack of Level Spaces: Terraces.*—Another great difficulty of the mountain farmer is the scarcity of level places for fields. He uses the valley bottoms, but they do not provide space enough. To get more land he must construct terraces on the hillside. In countries like China and Japan this has been done on an enormous scale. Whole mountain sides are often covered with terraces where walls 5

or 10 feet high have been built up in order to form terraces 20 or 30 feet wide. The labor of making such terraces and of keeping them in repair is so great that it helps to keep the mountain people poor.

**Cattle Raising among the Mountains.**—Since ordinary farming is so difficult, mountaineers try to make a living in other ways, for instance, by keeping cattle and sheep. These animals can easily graze on slopes too steep for cultivation. They can also be pastured on the rich grass which covers the valley floors and the mountain sides above the tree line. In California in June along the roads leading into the high Sierras, one must often pick his way through herds of hundreds of cows and calves or through flocks of stupid sheep that refuse to turn out for the passing automobile. The animals are being driven to the high mountains to graze during the summer.

In Switzerland the mountain meadows are called "Alps," and have given their name to the world's most famous mountains. Every summer when the snows disappear the people of the lower mountains move with their herds and flocks to châlets or huts among the flowery meadows near the snow-line. There they spend the summer caring for the cows and making butter and cheese. Such a life may be pleasant for a while, but it is lonely and unstimulating, so that the people who follow it are apt to be uneducated and backward.

**Tree Crops in Contrast to the Cereals of the Plains.**—In many respects tree crops are to the mountains what grain crops are to the plains. Although the world's most important food products are the cereals, including rice, corn, wheat, rye, barley, and oats, they are not adapted to the mountains. They need fine, deep soil, and a wide acreage, for the average yield per acre is relatively small, being only 15 or 20 bushels in the case of wheat. In order to be profitable they must be planted and reaped by machinery. All these conditions are met in the plains, but not in the mountains.

With trees the case is different. Although people often forget it, trees furnish not only fruit, but important food crops such as nuts, olives, berries, and forage seeds. In America this source of wealth is as yet little appreciated, but in the countries around the Mediterranean Sea it is highly important. Many kinds of trees grow quite as well upon hillsides as on plains. The rockiness of the soil makes no difference in their cultivation, for the land does not have to be plowed. Moreover, since there is no plowing the soil is not washed away so easily as where the crops are planted anew each year. The roots of the trees also hold the soil in place, while their leaves increase its depth.

Because of these conditions tree crops are highly profitable in regions of rugged relief. For example, in France and Italy rough, rocky hillsides planted with chestnut trees are sometimes worth as much per acre as our best wheat lands. Walnuts, chestnuts, beechnuts, pecan nuts, filberts, and butternuts all furnish excellent food for man and can be raised on steep slopes. So too, can the olive, which furnishes the best of vegetable oils.

Acorns, likewise, grow admirably on steep slopes. Although they are not a particularly good food for man, the Kurds in Turkey often grind them into flour for bread. For pigs, however, they are excellent. Great herds are fattened on them in the mountains of Serbia. In Spain pigs are also turned into the chestnut orchards to fatten on the nuts that have been dropped while the crop is being harvested. Sometimes the orchards are located on such steep slopes that farmers dare not turn in the large, fat pigs for fear that they may lose their footing and roll down.

Peaches and especially apples also grow excellently in rugged land. They are to-day the chief tree crop of the United States. Millions of acres, however, might be used for other tree crops and thus the mountain people might greatly increase their prosperity and at the same time add to the wealth of the country as a whole.

**Lumbering as a Mountain Industry.**—Trees for lumber as well as for food will always be more abundant in rugged regions than in plains. Many of the plains that are now densely populated were once covered with trees, but to-day in temperate latitudes forests are largely restricted to rugged areas which cannot be used for farming. Such forest lands are found in northern New England, the Adirondacks, the Appalachians, and the northern parts of Michigan, Wisconsin, and Minnesota. The Ozark region of Arkansas, parts of the Rocky Mountains, and much of the Sierra, Cascade, and Coast ranges are likewise forested. In Europe the words "forest" and "mountain" are almost synonymous. The terms "Black Forest" and "Black Mountains" are both used for the same part of Germany. Similarly in France the forests have been cut away so fully in all parts except the rugged uplands that a term like Argonne means both forest and highland.

Until the latter part of the last century lumber and firewood were abundant in the United States because new lowland areas were being cleared for settlement. Now, however, except for some of the sandy pine lands of the South, the main reliance of the country is almost wholly the forests of rugged areas. Even there so many trees have been cut and new growth is so slow that the supply of lumber does not keep pace with the demand. Hence the price of many kinds of wood is five or ten times as much as thirty years ago. This would be an advantage to the people of the mountains, but unfortunately for them keen business men of the cities bought up enormous tracts of forests before the country in general realized their value.

**Wasteful Lumbering Methods.**—In the past the method of lumbering has been very wasteful. The owners of timber tracts have often desired merely to get rich as quickly as possible. Therefore they have sent crews of woodcutters into the forests with orders to cut down everything that is large enough to be of any possible use. As the large trees fall they crash into the young ones and ruin them. Only the main trunks of the trees are used. The branches and the upper third of the trunk are wasted because transportation in forests and especially in rugged regions is so difficult that it does not pay to bring anything but the best timber out to the plains. When the branches become dry, a stroke of lightning, a match, a lighted cigar, or a camper's fire may start a forest fire that burns down the timber for hundreds of square miles. This is a terrible disaster, not only because of the trees that are destroyed and the people that are rendered homeless, but because the humus of the soil is burned up. In rugged regions the remainder of the soil thus left exposed is likely to be rapidly carried away by the rain.

**Forest Conservation.**—To-day a new method of lumbering is being introduced. People have begun to realize that if there were no permanent forest reserves we should be put to great stress to find a substitute for wood. Our condition would be like that of China, where the density of population and the dryness of the climate in spring and fall cause the country to have almost no forests. Wood is there so scarce that many people have difficulty in getting enough for doors, floors and furniture for their houses, and the coffins for themselves which they buy years before they die. So scarce is wood that the houses themselves are generally made of adobe, stone, or brick.

In spite of this danger we are still cutting the trees recklessly. Nevertheless the good example of European countries, such as France and Sweden, is beginning to be adopted under the leadership of the United States Forest Service. The Forest Service believes that the great forests ought not to enrich a few individuals, but should benefit everyone. To accomplish this they must be owned by the government, but there must be the freest opportunity for everyone to buy timber at reasonable terms. Accordingly large tracts of rugged land in all parts of the country (see Fig. 36) have been set aside by the national or State governments as forest reserves. Their total area in 1918 was nearly 200,000,000 acres, or more than the area of all the Atlantic States from Virginia northward, including Pennsylvania. In these tracts everything is planned so that bad trees are eliminated, good ones are planted, and the land is covered with

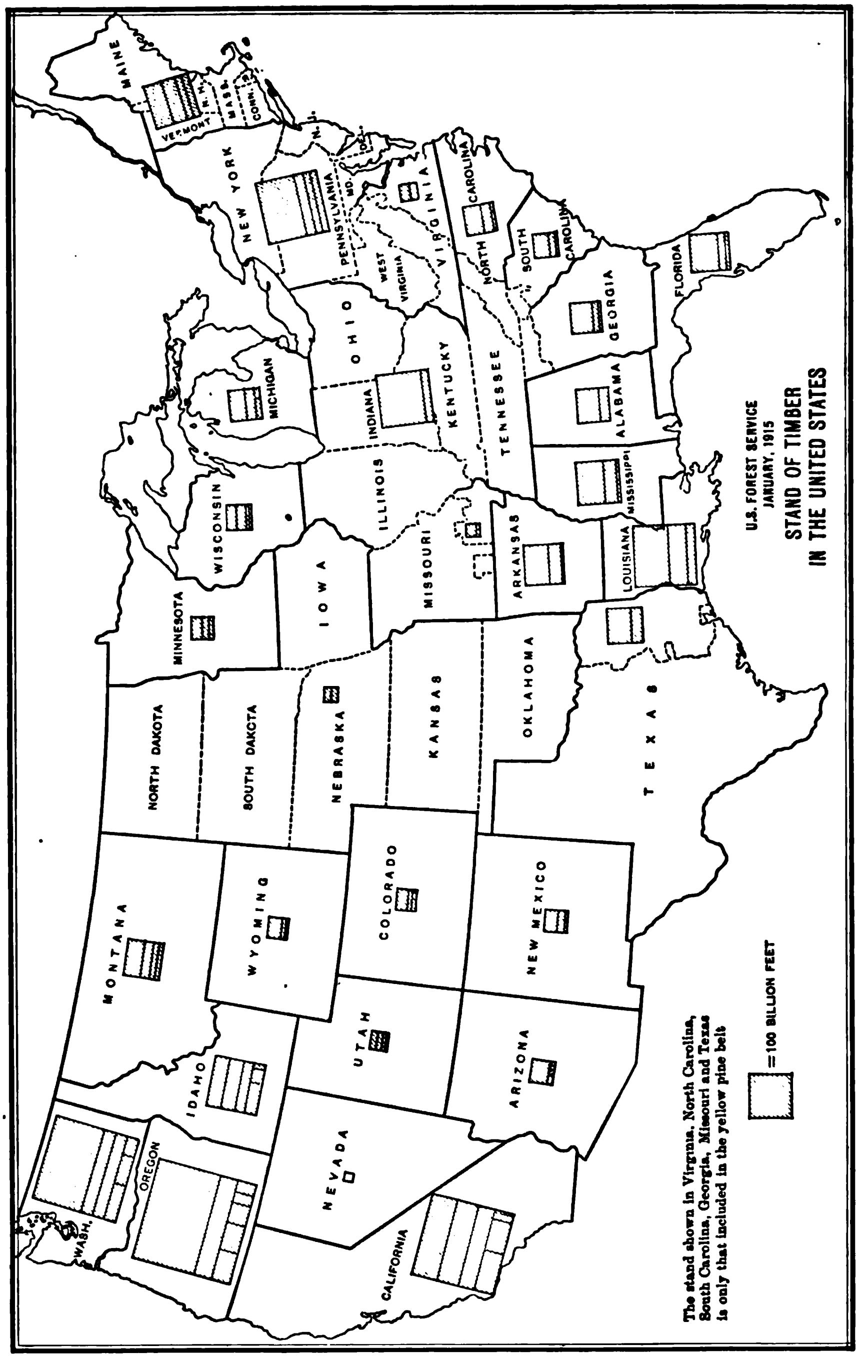



FIG. 36.—Forests in the United States.
The shaded squares indicate the amount of available timber. The lines within the squares show the relative amounts of different kinds of lumber.

trees of the right sort to maintain a steady supply of lumber. Anyone who chooses may buy standing timber provided he cuts only the larger trees, and fells them so that they do not damage the smaller ones. He must also dispose of the branches and useless tops so that there is no risk of devastating fires.

In addition to all this, the Forest Service maintains a corps of forest rangers and fire wardens. High on a mountain top a warden often lives all summer miles from the nearest neighbor. Every day at certain hours he goes to points of vantage and searches with his field glass for signs of smoke. If he sees signs of a forest fire he telephones to the foresters down in the valley, and a gang of fire fighters at once starts to put out the blaze. An aeroplane patrol in some places also aids in discovering fires.

**Why Civilization is More Backward among Mountains than in Plains.**—(1) *Scarcity of Good Artisans.*—A progressive community must contain not only farmers, lumbermen, and laborers, but skillful artisans, manufacturers, and professional people. Among the mountains this is almost impossible. Take the case of the most necessary kind of artisan, a carpenter. In the plains he usually does nothing but carpenter work, and hence is highly skillful. Among the mountains, however, there are so few people, they are so scattered, and the scarcity of good soil keeps them so poor, that little money is spent for new houses or improvements. Hence the carpenter can find work only a small part of the time. If he is really skillful and ambitious the chances are that he will move away to the lowlands where there is plenty of work. If he is less skillful or has little energy, he stays in the mountains and perhaps devotes part of his time to running a farm. Thus he excels neither as farmer nor carpenter. Since he is not a particularly good workman and his neighbors are poor, they employ him only a few days when they are building a house or barn, and do most of the work themselves. This teaches the mountaineers to try all sorts of work, but it results in many poor cabins and shacks.

Blacksmiths, masons, mechanics, plumbers, and other artisans find it still harder to get work among the mountains, and hence are scarcer than carpenters. Therefore the mountaineer has to do almost everything for himself, but because he must do so many things he rarely learns to do any of them unusually well—"Jack of all trades and master of none." It is the things that are done unusually well—better than ever before—that cause the progress of civilization.

(2) *Enforced Idleness.*—During the winter when there is little farm work, the mountaineers are often idle. At such times the lowlander can often find work not far away in factories, but this is diffi-

cult for the mountaineer. He must stay at home to take care of the animals, clear the snow, break out the roads, get firewood, and the like. If he were surrounded by neighbors as closely as is the farmer in the rich lowland it would be much easier to hire a neighbor to help with the chores while the farmer went away and earned money elsewhere. Sometimes this is possible, but if the nearest neighbor is a mile or two away and the roads are heavy with snow it may be a dangerous thing to leave wife and children alone. Therefore the mountain farmer stays at home in the winter and does nothing except his routine chores.

Some mountaineers are so energetic, however, that they engage in occupations such as the woodworking of Switzerland and the Black Forest. Since there is plenty of wood around them, the people have taken to carving it into all sorts of toys for children and also into elaborate patterns such as clock cases and paneling for churches. The women often make lace or embroidery. Woodworking, and embroidery, like the moonshine whisky described earlier, all represent a high value in a small compass, and can easily be transported out of the mountains. The mountaineers really export their skill, their raw material being of little or no value. Even so, the expense of marketing their products leaves the mountaineers a return much smaller than that of the lowlander for equally good work.

(3) *Professions.*—A large part of the new ideas of a community come from its professional people, its teachers, clergymen, lawyers, and doctors. Among the mountains they are under the same sort of disadvantage as the artisans. As the population is widely scattered, the schools and churches are small, and can pay only the most meager salaries. The schools are in session only a few months each year, and church services are held only occasionally. Only a few people are within reach of the lawyer and doctor who settle in a mountain valley.

Since the earnings of professional people are small, it is generally necessary to eke them out by engaging in some other occupation part of the time. The teacher may be also a carpenter, the lawyer a blacksmith, and the minister a mason, and all may carry on a little farming. Naturally such men do not have much time for study and the improvement of their minds; nor much money to buy the books and make the journeys to conventions that are essential if they are to keep up in their professions. Moreover, it is no easy life for a physician, for example, to have to take long rides on horseback in darkness and storm over poor roads or trails, and then be paid barely enough to live on. Unless teachers, ministers, lawyers, and physicians are working solely for the good they can do, those who have spent much time and money in preparing for their professions are unwilling to pass their lives in lonely places where the difficulties are so great and the rewards so few. Hence the mountains lose and the plains gain.

**Why Mountaineers are Bolder than Plainsmen.**—Mountaineers are generally bolder than the people of plains. This is partly because they are strong and healthy, but also because they have many experiences which never come to lowlanders. A mountain boy has no fear of wild animals because he often sees them. He dares to take off his clothes and wade through a cold turbulent stream that would give the city boy a bad fright and make him sick from the chill. The mountaineer is also bold because he frequently undergoes such hardships as tramping a score of miles in a vain search for game, or spending the night alone in the woods when he hunts for stray cattle on the unfenced mountainside.

Again, in backward regions poverty often makes the mountaineer bold and quarrelsome, for his envy of the richer people of the lowlands may embolden him to try to get a share of their possessions. Hence when times are particularly hard the mountain tribes of Persia and Afghanistan, for example, descend on horseback to raid the farms, plunder the houses, and drive off the cattle. In some regions such raids occur almost every year at harvest time. The lowlanders are so used to them that they build special towers of sun-dried brick to which they run for refuge when raiders are seen. The boldness of mountaineers was illustrated by the Gurkhas from the Himalayas in the Great War. More than any other soldiers from India they made the most daring kind of raids right into and across the German trenches.

**Why Feuds are Common in Mountains.**—When one man wrongs another in the mountains it is difficult to get redress through the law because the officials are usually far away in the lowlands. Among cowardly people this might mean that wrongs would go unrighted. Among bold, sturdy mountaineers, however, it leads men to try to right their own wrongs. Thus if a man is murdered, his brothers, sons, and other relatives feel that it is their duty to kill the murderer themselves. If they do so, the relatives of the murderer try in their turn to take vengeance. Thus family feuds arise, and may last for many generations. Sometimes a little quarrel over some trifle arouses people's anger and blows are struck. The quarrel thus started may go on for decades and cause the children and grandchildren and even the great-grandchildren of the first pair to lie in wait by the roadside to shoot one another. Not many years ago a Kentucky feud led the members of one family to come down to the courthouse in the lowlands, take a man out of jail with the connivance of the jailer, and shoot him in the public square. Such things would not happen if the isolation of the mountains had not forced people to look out for their own rights.

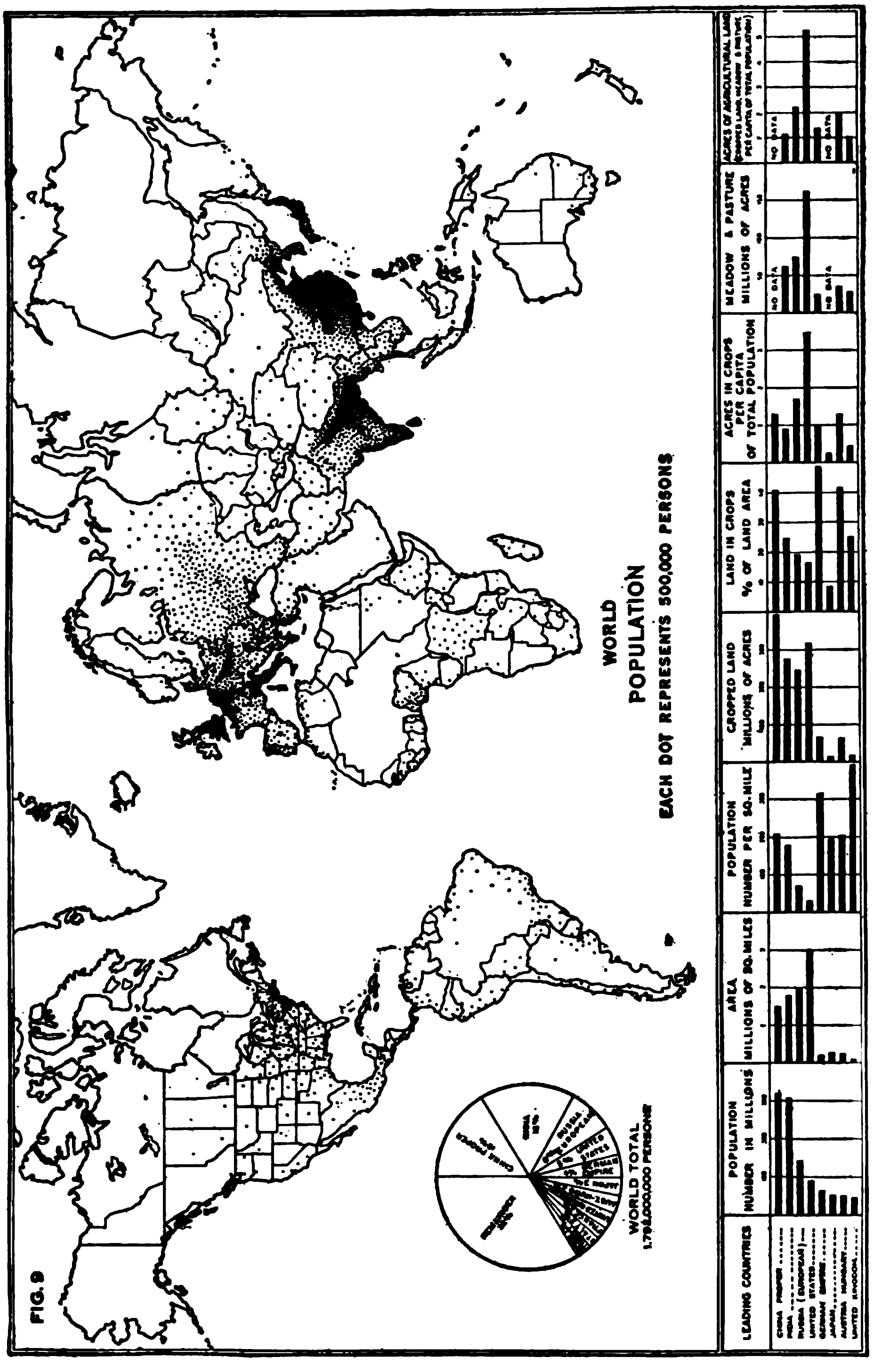
The very men who are fiercest in carrying on feuds often become some of the strongest and most valuable members of the community when they come down to the lowlands and learn the ways of more advanced communities. Often indeed, they surpass those whose ancestors have had every advantage for generations. In Scotland in past centuries the Highlanders used to raid the Lowlands most unmercifully. To-day the descendants of the raiders are among the most useful and capable people in the British Empire.

**How the Mountains Attract the People of the Plains.**—Just as the wealth of the plains has long attracted the people of the mountains, so the scenery and pure air of the mountains now attract the people of the plains. Only the most highly civilized people, however, have learned the value of the mountains as places for rest and enjoyment during vacations. Not more than a century or two ago civilized people like those of the lowlands of England and Germany thought of the mountains as places to be shunned. In old books the mountains are often referred to as terrifying, gloomy, frightful. Even to-day when people first look at a steep mountainside they sometimes feel dizzy. The vast majority of civilized people, however, now regard the mountains as a pleasure ground. Thousands of families escape from the city each summer in order to gain strength and happiness among the mountains. They want to enjoy the wildness, climb rugged peaks, and feel the exhilaration of the view from a mountain top.

In places like the Alps, the White Mountains, the Adirondacks, and certain parts of the Sierras the people of the mountains make a large part of their living by taking boarders, running hotels, supplying milk and vegetables, selling small articles made during the winter, acting as guides, and in other ways caring for tourists. In such communities the disadvantages of mountain life are much diminished. Since people no longer depend wholly on their farms, their prosperity increases They can have better schools, better roads, more books, better professional men and artisans, and more advantages in many ways. Since they come in contact with people from many lowland regions they gain new ideas, and their life is broadened and deepened.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Compare Figs. 37 and 38 until you are sure you understand how Fig. 37 by putting a dot for each million people, shows the *distribution* of population, while Fig. 38, by different grades of shading, shows the *density* of population, that is the number of people per square mile. Select four countries or large regions that




*From Geography of the World's Agriculture, By V. C. Finch, and O. E. Baker.*

FIG. 37.—World Map showing Distribution of Population.

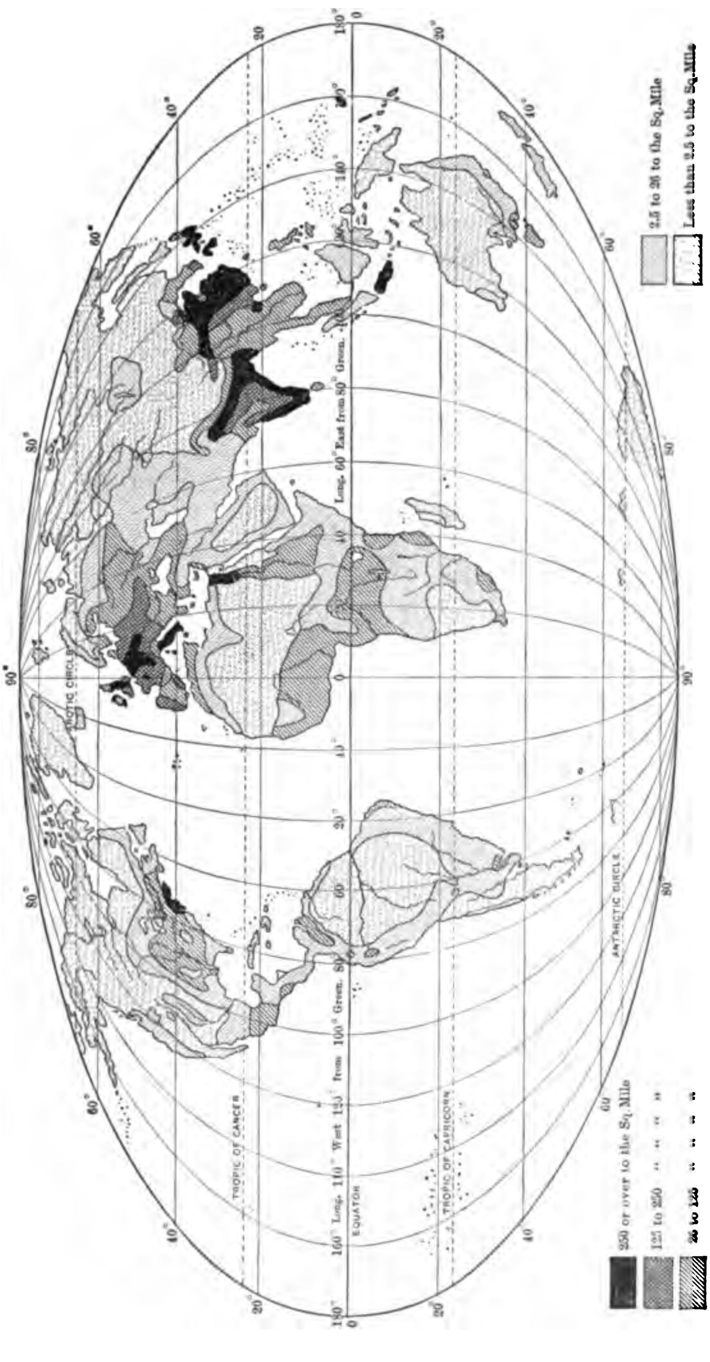



Fig. 38.—World Map Showing Density of Population.

are predominantly plains and four not far away that are mountainous. On the basis of Figs. 37 and 38, write a statistical account of the differences in the distribution and density of population in the two types of regions.

2. Figs. 34 and 35 illustrate the effect of relief on transportation. Contrast the two in as many ways as possible. Describe the effect on each of the modes of transportation shown in Fig. 34 if the grade of the valley floor were decidedly steeper.

3. Study the railroads that cross the Rockies. Name examples of lines which follow the valleys. Find out which ones avoid the valleys and run along the highland. Explain why this happens.

4. Select three parts of the world characterized as follows: (*a*) a region of plains, abundant rain, and slow rivers; (*b*) a region of gentle relief and exceedingly low rainfall; (*c*) a region of great relief where the higher mountains are always capped with snow. List the difficulties which confront a railroad engineer in each of these places. On the map determine how abundant railroads are in the places you have chosen.

5. Make a diagram to show the relief of your own State. Use the following scheme of shading: (*a*) heavy, for mountainous portions; (*b*) light, for the regions of low hills; (*c*) no shading, for the plains. Locate on your map the 20 largest towns of the State. Discuss the relation between the relief and the location of the towns. If your own State does not show marked relief, choose any other in which you are interested.

6. Study the capitals of Europe in relation to the relief. Classify them according to location as follows: (*a*) near the centers of plains; (*b*) on the edges of plains; (*c*) in narrow valleys or among the mountains. Explain the reasons for the relative numbers of the different types.

7. A good seaman has been defined as "one who can turn his hand to any task and who can make the best use of any material he may happen to have." Discuss the extent to which this is true of a mountaineer as compared with a plainsman. Show specific features of the geographic environment which lead to your conclusion.

# PART IV

## *MAN'S RELATION TO BODIES OF WATER*

## CHAPTER V

### THE INFLUENCE OF THE OCEANS

FEW features of man's geographical surroundings are more important than the division of the earth's surface into continents and oceans. At first thought one might say that only the lands are really necessary. We live on the lands; their soil yields food for man and beast; the lands contain mines from which we extract minerals; we travel chiefly upon the lands; and even when we traverse the oceans it is only to reach some other point upon the lands. It would seem that the ocean merely covers three-fourths of the earth's surface which might otherwise form fertile plains supporting millions upon millions of people. Such a view is wrong, however, for the oceans are as necessary to man as are the lands. They are of the greatest service in the following five respects: (1) as a source of rain; (2) as regulators of temperature; (3) as an aid to health; (4) as a source of minerals; and (5) as a source of food. Oceans also serve (6) as barriers, and (7) as carriers of commerce. In these two respects the relation of the oceans to transportation is the reason for their profound effect upon man's life. In most respects large lakes act in the same way as oceans.

**Why the Oceans are Important.**—(1) *As a Source of Water for Clouds and Rain.*—Even in the heart of a continent much of the rain consists of moisture wafted thither by winds from the ocean. If the crops depended only on moisture evaporated from the lands including their lakes and rivers, they would be as scanty as in deserts. Nebraska and the Dakotas, although in the middle of a continent, raise millions of bushels of wheat by means of water from oceans over 1000 miles away. Practically all the world's corn crop depends on summer rains from oceans 500 to 1500 miles away. This is not surprising for two chief reasons: (*a*) The evaporation from the land is usually less than from the same area of water, as is evident from the dampness of a sea breeze compared with the dryness of a land breeze; (*b*) the area of the oceans is two and a half times that of the lands, and two hundred times that of all the lakes, rivers, swamps, and other bodies of water on the lands, including the great Caspian Sea. If all the lakes in the world should be evaporated they would supply only one-fifteenth of the rain that falls each year on the lands.

(2) *Oceans as Regulators of Temperature.*—In addition to supplying moisture the oceans prevent the land from becoming too hot or too cold. Water becomes warm much more slowly than the materials that form the land, and is correspondingly slow in cooling. Moreover since water is easily movable it is blown about in the form of currents which carry warm water from the torrid zone toward the poles and cold water from polar regions toward the equator. Because water heats and cools slowly and because the warm and cool parts are mixed by currents, the ocean is warmer than the lands in winter and cooler in summer. Hence winds that blow across the oceans are warmed by the water in winter, and cooled in summer. Thus when they reach the lands they make the summers cooler and the winters warmer than they would otherwise be. How great this effect is may be seen by comparing Seattle, Washington, where the Pacific Ocean influences the temperature, with Bismarck, North Dakota, which is far from either ocean. In January while the farmers around Seattle are plowing in an *average* temperature of about 40° F. for day and night together, those around Bismarck, where the average is only about 7°, can do little except feed their cattle and protect them from blizzards. In July, on the contrary, the average at Seattle is 64° and at Bismarck 70°, so that wheat grows much better at Bismarck than at Seattle. If there were no oceans all parts of the United States would have extremes much greater than those of Bismarck so that the summers would be unbearably hot and the winters unbearably cold. It is well that the continents are surrounded by great oceans.

(3) *The Ocean as an Aid to Health.—The Sea Coast.*—As comparatively few people sail the sea, the coast is the place where the ocean exerts its influence directly upon the greatest number of persons. There the oceans are a wonderful aid to health in five chief ways: (*a*) Extremes of temperature are rare; (*b*) extreme dryness is also rare; (*c*) small short-lived changes of temperature from day to day and even from hour to hour are frequent; (*d*) the variety and beauty of the seashore tempt people to engage in outdoor sports such as bathing, fishing, and walking; (*e*) the ocean is a wonderful purifier, and not only carries away but destroys most impurities brought into it from the land.

The first three of these favorable conditions all arise from the winds that blow from the sea. Almost as soon as a land breeze begins to cause extreme heat in summer or extreme cold in winter, a sea breeze brings a change and causes the temperature to moderate. The only unfavorable effect of the seacoast upon health in temperate latitudes arises from the fact that during " hot spells " in summer the dampness of the sea makes the heat harder to bear than when the air is dry. Prostrations and deaths from heat in New York City, for example, are often due to this cause, but such occasions are so rare that they are a small matter compared with the benefits derived from being near the sea. The combined effect of all five upon health is to cause much of the shore from Maine to Florida to be lined with summer cottages.

**Recreation on a Submerged Coast.**—In Maine the summer visitor delights in the beauties of a submerged coast, where innumerable deep bays dotted with picturesque rocky islands tempt him to sail and enjoy their beauty, even if he does not care to catch the fish which abound in the cold water. The intervening peninsulas with their garment of spicy pine forests and their rugged cliffs worn by the ever-gnawing waves tempt him to go on long walks or to sit at the top of some bluff and watch the dashing waves, or catch fish from the rocks. The materials worn from the rocky cliffs on the outer part of the peninsulas and capes are carried by the currents to the heads of the innumerable bays, and there form little beaches where boats can safely be drawn up, and where on sunny days the water may become warm enough to permit bathing.

**Recreation on an Emerged Coast.**—Farther south in Florida the fact that the coast has emerged gives rise to broad sandy beaches. The surf rolls in magnificently to the pleasure not only of the spectators who sit in the sun on the beach, but of the bathers who can enjoy the warm water for hours each day. Children delight to dig in the dry sand near high tide level, and watch the pelicans open their enormous bills. Between the levels of high and low tide the damp beach is so hard and smooth that it offers an almost ideal place for automobile races. Boating is not so easy as on the submerged coasts, farther north, for only where streams enter the ocean can even small boats be kept. When the boats get out to the sea, however, they afford the finest kind of sport in catching fish like the baracuda.

A few weeks of ocean air and pleasant recreation on almost any seacoast of the United States at the right season make one feel full of energy and ready for all sorts of work. It must not be overlooked, however, that part of the benefit is due to the change from home conditions, together with the outdoor life, and the opportunities for new forms of recreation.

**How Coasts Benefit the Health of the Tropics.**—In tropical countries the cooling effect of the sea is especially important. Winds from the sea temper the constant heat and make people feel much more like work than is possible for those who live farther inland. The ocean winds also drive away the mosquitoes and other insects which are so great a menace to health and comfort. For these reasons a surprisingly large part of the people of equatorial Africa, for example, have placed their high-pitched cottages along the shore where the afternoon sea breeze serves as the " doctor."

**How the Ocean Disposes of Sewage.**—Another important function of oceans is their help in disposing of sewage. One of the most expensive duties of the modern cities is to get rid of the sewage in such a way that it will do no harm. In general the sewage is conducted into some neighboring body of water. If the water is in motion the sewage is carried away and greatly diluted. Thus in a short time the water purifies itself so that even the most careful analysis fails to show pollution. If sewage is conducted into a body of standing water without marked currents, however, the water becomes polluted and may prove a source of grave danger. Chicago found this to her cost when she tried to dump sewage into one part of Lake Michigan and take drinking water from another. She had to spend about $40,000,000 in order to build a drainage canal deep enough so that the dirty Chicago River, into which the sewage pours, would flow toward the Mississippi River instead of toward the lake. On the sea coast, especially where there are strong tides, the difficulties of disposing of sewage are reduced to a minimum. In some coast cities such as Boston, for example, part of the sewage is held in reservoirs until strong outgoing tidal currents have developed. Before the turn of the tide it has been carried so far that it has become mixed with an enormous body of ocean water and has become harmless.

(4) *The Ocean as a Storehouse of Minerals.*—Since 3½ per cent of the weight of sea water consists of solid mineral matter in solution, the ocean serves as a storehouse of minerals. Every stream and river carries a small amount of such material in solution. When the water reaches the sea the liquid eventually is evaporated and goes back to the land, but the mineral matter remains. Thus the sea has slowly accumulated a vast amount of common salt, lime, potash, phosphorus, and many other materials. Even gold and silver are included, but in amounts so extremely small that they cannot be recovered at a profit.

(*a*) *Salt.*—The only dissolved material that man takes from the water in large quantities is common salt. On warm sunny seacoasts where the water is shallow, large ponds are often banked off by dykes.

Here the water evaporates until the salt crystallizes out. On the shores of the Mediterranean Sea near Smyrna, for example, and on the coasts of Central America, great piles of white salt crystals often form gleaming cones. Most of the world's salt, however, comes from ancient deposits like those at Syracuse and Stassfurt, and was laid down long ago in salt lakes whose waters very slowly dried up in the same way that the water of the enclosed ponds on the seashore now does.

(b) *Limestone.*—Aside from salt, the most valuable mineral in seawater is lime. Shellfish constantly use this for their shells. Some of the shells are thick and heavy like those of clams, oysters, and the great edible abalone of the Pacific coast. Others are beautifully branched like many corals. Still others are so small and thin that they cannot be seen by the naked eye. Such are those of the globigerina ooze, a soft mud which covers large areas of the sea floor, and which would form chalk if converted into stone. One or another of these kinds of shells has given rise to vast deposits of limestone. Since the sea once encroached far into what is now the continental interior, large deposits of limestone are found in most parts of the country. Without them we should be at a loss to make cement and concrete, to obtain lime for mortar and plaster, and to find the flux so essential in the smelting of iron.

(*c* and *d*) *Potash and Phosphorus.*—Certain other valuable materials, although present in quantities too small to be profitably extracted by man, are taken from the seawater by plants and animals. One of these is potash. A certain alga or seaweed called kelp contains so much potash that it is gathered by seacoast farmers as a fertilizer. According to the United States Department of Commerce the kelp crop on our Pacific coast would be worth $100,000,000 per year if properly harvested. Another valuable fertilizer, phosphorus, is taken from the seawater by fish, and is found in their bones and scales.

(5) *The Ocean as a Source of Food: Marine Vegetation.*—Except where waves and currents are too violent the sea floor from the level of high tide to a depth of about 600 feet is largely covered with plants, chiefly of the kind called algæ. In deeper water plants cannot grow because there is no sunshine. Even in mid-ocean, however, as far down as the light penetrates, the water is full of microscopic one-celled plants, small larvae and other minute animal forms. When the "plankton" dies much of it sinks so that even in mid-ocean minute bits of vegetable and animal matter fall constantly. The ocean vegetation is of little direct use to man, but it furnishes a vast supply of food for organisms like oysters, shrimps, and fish, which in turn are eaten by man.

**How Man Utilizes the Food in the Ocean through Fisheries.**—The presence of vegetation and hence of fish in the ocean gives the people of the sea coast an advantage because they can carry on fisheries as well as the ordinary occupations of the land. The word fisheries means not only the work of catching fish, but of gathering mollusks or shellfish like the oyster and clam, crustaceans like the lobster and crab, and even mammals like the whale and seal. The fisheries of the United States furnish an amount of food equal to nearly half the pork consumed in the country. In countries like Norway and Japan, where the mountains make farming difficult and where the deeply indented coasts are favorable to navigation, fish form the most important animal food. In Japan the traveler is surprised by the variety of ways in which they are served, for in addition to the ordinary dishes, he may be offered raw fish with salt and pepper, or a soup made of the water in which fish have been boiled. In our own country fish are used chiefly near the indented coasts of the rugged northeast and northwest, but form an important element of diet in most parts of the country.

**Shallow-water Fisheries.**—Fisheries fall into two classes according to whether they are carried on in shallow waters near the coast, or in deeper waters out in the open sea or on ocean "banks." Many shallow-water fisheries are concerned with shellfish and can be carried on without the use of boats. Clams, for example, are dug in large numbers at low tide on the New England and Middle Atlantic coast. The oyster "crop," which amounts to a third of the value of all the fisheries in the country, is dredged from the bottom in water not over 100 feet deep. About five-sixths of the world's oysters come from the Atlantic coast of the United States, especially from Cape Cod to Cape Hatteras. The lobster, which lives in shallow waters, especially on the Atlantic coast from the Delaware River to the Saint Lawrence, is so highly prized that the United States has been obliged to pass stringent laws to conserve the supply: hence our chief supply now comes from Canada.

**The Government and the Sea Floor.**—The animals in the shallow oceanic waters are so valuable and the demand for them so great that the government has been obliged to help in two respects. First, it is trying to increase the supply by protecting the eggs and raising young animals in huge quantities until they are large enough to be free and shift for themselves. Second, it is setting aside certain parts of the sea floor for a sort of private ownership, so that people may care for the eggs or spawn of the oyster, for example, and see that the young oysters have a chance to grow. This makes it worth while for a man not only to place old oyster shells or tree branches in the water to provide lodging places for the spawn, but also to hatch oysters artificially and place them in beds on the sea bottom. He knows that the government will protect his right to harvest the crop that he has planted, and will punish unscrupulous people who come on a dark night or in a fog to steal the crop, just as it will punish the thief in a peach orchard.

**Salmon Fisheries.**—The chief shallow-water fisheries are concerned with animals that live at the bottom of the sea and do not travel great distances. Some, however, are concerned with genuine fish such as the shad, sardine, herring, and salmon that travel long distances in great shoals in order to reach their feeding ground or to find safe places where they may lay their eggs and where the little fish may grow up. During the spawning season the lower parts of the rivers that empty into the Pacific Ocean from California around by Alaska to Japan are crowded with salmon. So numerous are the fish that great waterwheels are sometimes arranged so that as the current turns them they throw the fish out into boats. The rest of the fish come crowding on regardless of those that are captured. In the cold rivers of Alaska multitudes of salmon are caught by men who go there for a month or two each summer simply for that purpose. No other fish is so extensively canned.

**Deep-sea Fisheries.**—The deep-sea fisheries are centered in the "banks," or oceanic shallows of three chief regions. One region extends from George's Bank off Cape Cod to the banks of Newfoundland and Labrador. This is the fishing ground in which the United States is chiefly interested, for although fishermen come there from Europe and Canada, the greater part of the catch is made by New Englanders, especially by men from Gloucester, who take their fish to Boston.

The second region includes the banks of the North Sea, where the world's greatest fisheries are located. With these may be included the fishing regions off the coasts of Norway near Iceland, Faroe, and other islands. The third region is the Pacific waters near Japan and northward, where thousands of boats scour the seas for the fish that form the main animal food of the fifty million Japanese.

The banks on which all these fisheries are located are shallow places where the depth does not prevent the light from reaching the bottom, and hence where great quantities of algæ provide food for the countless small animals on which the larger fish prey. The most important fish is the cod, which is usually salted and dried. It is shipped to all parts of the world. In the early days of New England the codfish was so important that several times the colonists would almost have starved without it. Therefore it is fitting that a cod should hang over the chair of the President of the Massachusetts Senate.

**Location of Fishing Communities.**—The world's chief fishing communities are all alike in three important respects. (*a*) They are located in comparatively northern latitudes; (*b*) they are in regions where agriculture meets with special difficulties; and (*c*) they are upon submerged coasts. Let us study these three conditions.

(*a*) *Effect of Latitude.*—One of the reasons why fisheries have developed in high latitudes rather than near the equator is that fish can easily be preserved in cool climates, but not in warm. When fish are caught far from land it is impossible to dry them. The only way is to salt them down in the ship's hold. This is successful only in high latitudes, for elsewhere the fish will not keep. The people of the tropics generally catch fish only for immediate consumption. The modern process of cold storage, however, is at last making it possible to catch fish profitably on a large scale in tropical regions, and thus opens up an enormous and almost untouched source of food.

A second reason why fisheries have developed in high latitudes is that fishing takes a great deal of energy. On the sea, as on the land, the development of new resources waits for the active people of the North. The adventurous spirit of the northerners seems to lead them to go to sea out of sheer curiosity even if there is no other reason.

(*b*) *Fisheries and Agriculture.*—Another reason for the development of fisheries in high latitudes is that agriculture is there difficult. In cool northern lands like Norway or Newfoundland only a scanty living can be obtained from agriculture, partly because the land is hilly, but still more because the climate is too cool. Therefore such people are forced out onto the sea. In a less degree the same is true of New England, England, Brittany, and Japan.

(*c*) *Fisheries and Submerged Coasts.*—Along some coasts the land has recently been submerged. On such *drowned coasts* the water has filled the valleys with bays and left the ridges as headlands or islands. In North America such coasts are found along the north Atlantic shore from Virginia to Labrador, and on the Pacific coast north of San Francisco. In Eurasia they are found around the North Sea and northward to Scandinavia, and in Japan and the regions farther north. On submerged shores innumerable little harbors tempt people to keep boats. The island headlands arouse curiosity and lead people on and on. When storms arise an island or a bay usually offers shelter. The land behind the coast is apt to be hilly, so that people are forced to seek the level land along the shore. Thus in such surroundings many conditions combine to cause a large portion of the people to be familiar with the sea, and to give them confidence to undertake short trips within sight of land, and then long adventurous voyages across the ocean.

**Fisheries as a School of Seamanship.**—On such voyages no one can succeed except men who have learned the art of bravely enduring difficulties and who have great strength and courage. On the Newfoundland Banks, for example, the fishing fleet, partly steamers and partly schooners, often lies for weeks in the cold fogs. On the Banks the fishermen are exposed to the danger of being run down by great ocean "liners," for the fishing grounds are near the route from England to America. Icebergs often bear down upon a boat and sometimes overwhelm it before they are seen. In the fog the small boats that are sent out to take the fish from the trawls and rebait the hooks occasionally lose their bearings, and may never be able to get back. Even when the boats are in no danger, the work is miserably wet, cold, and tiresome. Ages of such fishing have bred courageous qualities in New England, the Maritime Provinces of Canada, Norway, Great Britain, and Japan. This has greatly helped to give those regions a foremost rank in commerce. The fishing fleets are the school of seamanship, and from them come the men who make it possible for a great fleet of merchantmen to be developed.

Norway furnishes the best example of the effect of geographical conditions upon fishing and thus upon commerce. Her abundant harbors, bracing northern climate, and agricultural poverty cause her to have a merchant marine surpassed only by those of the far more populous countries such as Britain and the United States. Italy illustrates the matter in another way. The coasts of Italy are not particularly well supplied with harbors and the land is fertile. Accordingly, from the days of Cæsar to our own, Italian ships have been largely manned by sailors from the submerged and relatively sterile Dalmatian coast on the other side of the Adriatic Sea. This condition led to a serious quarrel at the end of the Great War. Italy wanted to keep the Dalmatian coast, especially Fiume, because of the little Italian seaports along it, but the other powers thought Jugo-Slavia ought to have this coast.

(6) *Oceans as Barriers.*—From the earliest times the ocean has been a barrier, but its importance in this respect is steadily decreasing. For thousands of years the Atlantic, the Pacific, and the other oceans were such barriers that people never crossed them. That is one chief reason why the race of men and the species of animals and plants in Australia are so different from those of the other continents. That is also the reason why the great land mass on one side of the world is called the *Old World*, while the two continents on the other

side are the *New*. Not till 1492 did any Europeans except the Norse cross the Atlantic barrier to the strange lands of America. They marveled at the Red Men, they were surprised to find a new grain known as maize, a new vegetable called the potato, a weed which people smoked in pipes, and a host of other things which were unknown to them because they had not been able to cross the water.

How effective the ocean barrier may be is illustrated by the life of Napoleon. After he had been conquered by the English, Spanish, and Germans he was sent to the island of Elba as an exile. There, however, the water that separated him from France was so narrow that he escaped from exile and returned to lead his armies once more. Then when he was again conquered at Waterloo in 1815 he was sent to the little island of Saint Helena, separated even from Africa by a barrier of 1200 miles of water, and from France by 5000. He could not escape, and so spent the rest of his life there. Like the lighthouse keeper on a rocky island during a storm, he was held in one small place because he had no means of crossing the ocean barrier.

**Water as a Defense against Enemies.**—Water barriers are as effective in keeping people out as in keeping them in. In prehistoric times our ancestors protected themselves by building their huts of poles and bark on piles in the shallow water near the shore of lakes. The same method is employed at present in New Guinea and other East Indian Islands. A narrow walk leads from the shore across the water to the huts. Part of the walk consists of a plank which can be lifted from the seaward side. Thus when a community is gathered in its huts with the canoes tied under them and the plank raised, enemies have hard work to approach because of the barrier of water.

**Water Barriers of Great Britain.**—Great Britain is almost like a home on piles with the plank drawn up. It lies close to the coast of the most progressive part of Europe and can communicate freely with the rest of the world when it so desires. Yet it is separated by a narrow body of water which checks and delays whoever would approach uninvited. Although the twenty miles of water between Dover and Calais once made England isolated and backward, they have in the long run been of almost incalculable value to that country. In the later decades of the last century and the earlier ones of the present when the other great Powers of Europe were spending untold millions in preparing vast armies, England was content with only a small army, and saved her money either to develop the industries of peace or to build warships. She knew that because of the water no large army of invaders could quickly be landed on her coasts, and that she was safe from attack. So much did she value her island position that after a tunnel under the English Channel was actually begun, the project was abandoned. England did not wish to build an easy entrance to her front door and thus perhaps give an enemy the opportunity to bring in an army. For the sake of safety she proposed to compel those who came to her to come in boats.

When the Great War came, Germany could do little harm to the island empire, try as she might. Even dirigibles and airplanes wrought only intermittent and local destruction on the English coast and in London. The island as a whole was unaffected. In the end, because England's water boundaries had led her to develop a great navy, she maintained control of the sea, and cut off a large share of Germany's foreign commerce, while she herself was being greatly helped by supplies and ammunition from America and elsewhere. When America was ready to enter the war, British ships carried more than a million of our men overseas.

**Water Barriers of Japan.**—Aside from Great Britain many other large islands have the advantage of protection by water. Only Japan, however, has so stimulating a climate and is located so close to a continent that it reaps an advantage similar to that of Britain. Japan, to be sure, has the disadvantage of being far from the center of the land hemisphere and of having no highly advanced neighbors close at hand. On the other hand, her island position has allowed her to develop her civilization without being swamped by the barbarous invaders who have again and again entered China from the bleak deserts of Central Asia. In our day Japan is fast building up a navy and acquiring a large merchant marine, so that she follows closely in the footsteps of Great Britain.

(7) *Oceans as Carriers of Commerce.*—Although the oceans serve as barriers they are also a great help in transportation, provided people can build the right kind of boats. Transportation by water is the cheapest known method, and hence the oceans carry a vast volume of commerce. Let us compare this method with others.

**The Low Cost of Ocean Transportation.**—The cost of transporting goods by hand sledges across snowy mountains is sometimes as high as $20 per ton for a single mile. That is what it cost, for example, when the Klondike mines on the Yukon were first opened, and supplies had to be carried from southern Alaska. To carry a ton a mile in the air costs several dollars, although the rate is fast decreasing. The cost by rail is far lower, being less than two cents in the more thickly settled parts of the United States. On the oceans, however, this low rate falls still lower, that is, to less than a fifth of a cent per mile for a ton. This is only about a tenth as much as by rail, perhaps a hundredth or a thousandth as much as by the airplane or dirigible and a ten-thousandth as much as by sledge over Arctic mountains.

**Why Ocean Transportation Costs so Little.**—(*a*) *The Free Highway.*—Transportation by sea costs far less than on land for several reasons. In the first place the ocean is a ready-made highway free to all, hence ocean transportation is not burdened with three classes of heavy expenses that are borne by railroads: (*a*) *Construction.* Trains require tracks which may cost only $20,000 per mile in a smooth plain where wood is abundant. Generally, however, the cost is nearer one or even two hundred thousand dollars per mile including roadbed, stations, sidings, and so forth. Among mountains the cost is much greater. The interest paid annually on this expenditure is an important item in the cost of land transportation. (*b*) *Maintenance.* Large sums must be paid by the railroads to maintain the road bed in good condition. Since the tracks wear out, they must constantly be watched by track walkers and repaired by section men. (*c*) *Taxes* are another item. Even in Maine, where there are only about 2300 miles of track, the railroads pay about $600,000 per year in taxes.

(*b*) *The Small Amount of Power Needed on Waterways.*—Another important advantage of transportation by sea is that less power, and hence less coal and oil, are needed by steamers than by trains to do the same work. A person of ordinary strength can push a 40-ton boat away from a wharf, provided wind and tide do not interfere, but he could not start a freight car weighing forty tons without the aid of some mechanical appliance like a lever. Again, the ocean is absolutely level, while no railroad can be free from grades for more than a limited distance. The grades are expensive because the loads must be lifted. Of course they are not lifted straight up, but the total amount of work is the same as if they were.

(*c*) *The Small Number of Men Needed on Ships.*—Another advantage of water transportation is that a given load on a steamship requires fewer men than on a train. A good-sized freight steamer registered at 12,000 tons can actually carry more than 25,000. Such a ship travels steadily at the rate of about 15 miles an hour, which is quite as fast as a freight train when allowance is made for the time spent in waiting on sidings or in the yards where new trains are made up. To carry 25,000 tons of freight would require about 20 trains of 30 cars each. Each train requires a crew of at least five or six men, and three crews are needed during the twenty-four hours. In addition some attention is required from many station agents, train despatchers, flagmen, switch tenders, oilers, and others, so that the total amount of work is equal to that of about 36 men for each train, or 720 for the 20 trains. A 12,000-ton steamer, if used only for freight, needs a crew of only about 100 men.

(*d*) *The Low Cost of Building Ships as Compared with Locomotives.*—The cost of building a steamer is less than that of the corresponding trains. An average locomotive costs $70,000 and a freight car about $3500, so that a 30-car train would cost about $175,000, and 20 trains about $3,500,000. A 12,000-ton freight steamer could be built for $2,000,000.

(*e*) *The Safety of Water Transportation.*—From the point of view of safety water transportation has an advantage. The proportion of passengers lost at sea is less than on land, while in the number of accidental injuries to employees the conditions at sea are still more favorable. Every accident costs something for damages, so that even in this respect transportation by water costs less than by land.

**The Role of Harbors in Water Transportation.**—Transportation on the ocean would be as difficult without harbors as would railway traffic without stations and freight yards. A good modern harbor must furnish (*a*) *protection* from winds and waves, (*b*) good *depth* of water in the channels and close to the shore, (*c*) abundant *anchorage* room, and (*d*) plenty of *space for docks*. A harbor may possess all these qualities, however, and yet not lead to the growth of a great city, as may be seen at Mount Desert in Maine and in the many deep bays that border the Gulf of California. It needs also (*e*) abundant *level land* for city buildings, (*f*) easy *lines of communication* with the interior, and (*g*) a rich "*hinterland*" or "*back country*" in which to sell imported products in exchange for raw materials, food, and manufactured goods.

(*a*) *Why Harbors Need Protection.*—No matter whether people use primitive canoes or huge modern steamships, navigation is much hampered unless the harbors are well protected. Islands and headlands break the force of the winds and waves and thus, by preventing the boats from being tossed about and perhaps dashed against the shore or against one another, make it easy to load them at all times. So important is protection that millions of dollars are spent annually for breakwaters.

(*b*) *The Constant Demand for Deeper Harbors.*—The depth of the water in a harbor becomes increasingly important with the growth of civilization. For small sailing ships, harbors 10 to 20 feet deep are sufficient. So long as such ships were the largest that sailed the ocean it was possible for a port like Salem, Massachusetts, to do more business than Boston, and almost as much as New York, while Newburyport, Gloucester, Fall River, New Bedford, New London, and many other places were almost equally important. When the steam engine was invented, and still more when steel took the place of wood in building vessels, the size of ships began to increase rapidly.

The size of ships also increases constantly because large ships are more economical than small ones. A freight steamer costing $500,000 and requiring a crew of 40 men will carry twice as much as two smaller steamers costing $600,000 together and requiring 50 men. Some modern ships have a "tonnage" of 50,000 tons and could carry over 100,000 tons of freight if they did not give up so much space to passengers. Such a ship is nearly 1000 feet long, 100 feet wide, and over 60 feet from the keel to the upper deck. It needs from 35 to 40 feet of water. For such steamers a shallow harbor, no matter how well protected, is useless. Practically no important ports, however, have natural harbors with any such depth. Hence each year millions of dollars are spent by the national government in order to deepen harbors, while cities and States also make appropriations for it. In a decade the national government has spent as much as $4,000,000 on the improvement of the approaches to Philadelphia alone.

**The Depth of American Harbors.**—At present New York and San Francisco are the only American seaports having channels deep enough for great steamers drawing 40 feet. The people of Boston talk about a 45-foot channel to accommodate not only all present ships but the still larger ones that are expected in the near future. At present the Boston channel is 35 feet deep, which is practically the same as that of Philadelphia, Baltimore, Norfolk, New Orleans, and Seattle. Such important ports as Oakland and Los Angeles, where the original depth of part of the harbor was only 2 feet, and Galveston, have 30-foot channels; Charleston, 28; Savannah, 27, and Tampa and Mobile, 26. No other harbors in the United States have such deep channels. With the growing tendency to build large ships the more favored ports are bound to grow more and more at the expense of those with shallower channels.

(c) *The Need for Roomy Harbors.*—Deep water is needed not only in the channel but in places not far from shore where vessels can find room to anchor and turn around. A 1000-foot vessel needs nearly half a mile of free space in which to turn around, even though she has the help of tugs. When the great *Imperator* first came into New York Harbor the captains of some of the other boats in the North River did not realize how much room she required in order to turn and get into her berth in the dock. Consequently she bumped one or two other ships, ran into a wharf, and did such damage that her landing cost $45,000. Because of the large area required to maneuver modern steamships a river such as forms the harbor at Savannah is rarely so valuable as a bay along a submerged coast like that of the Atlantic from Norfolk northward, or the Pacific from Puget Sound northward.

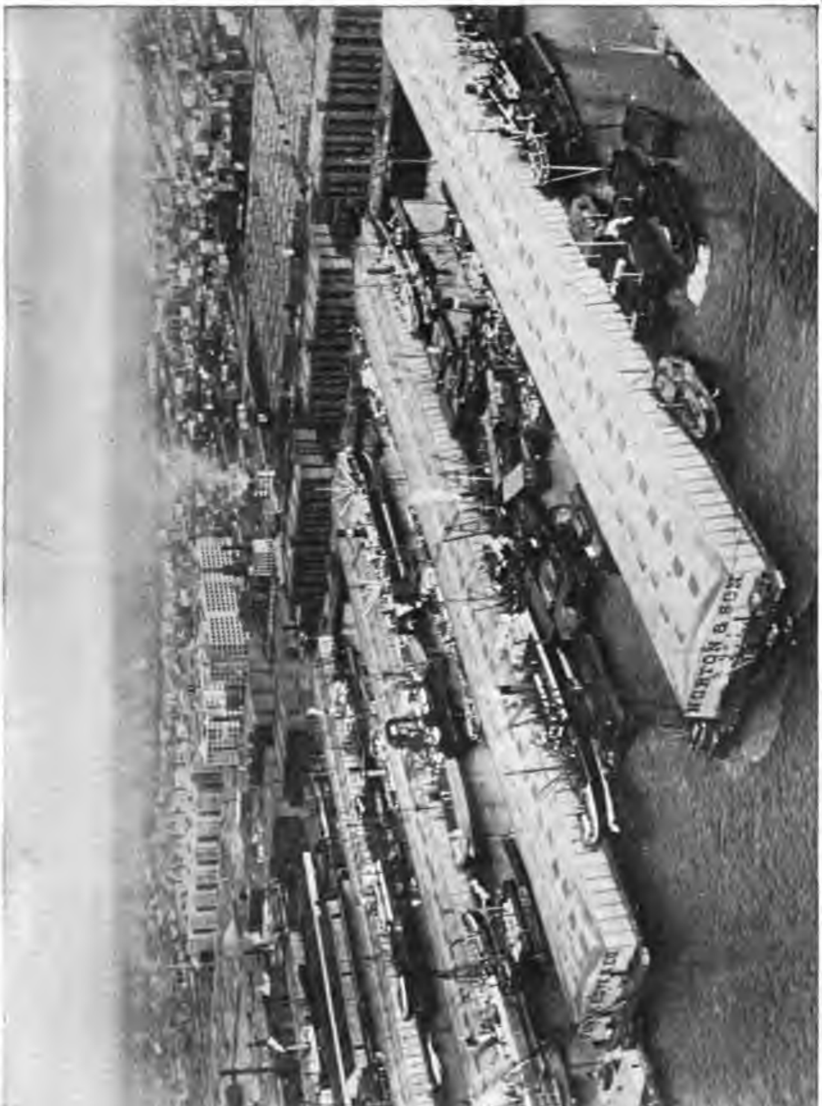
(*d*) *Dockage Space as a Necessity of a Good Harbor.*—Harbors on submerged coasts not only furnish ample room, but also adequate dockage space. Liverpool, for example, on the estuary of the Mersey, where it has been easy to build many docks, has a great advantage over Shanghai, on the Yangtse delta, where ships have to discharge their cargo into lighters while at anchor in the middle of the river, five miles from the city. In bays formed by submergence the long shoreline and deep water close to the shore enable numerous docks to be built, so that steamers can be loaded directly from the land. It is an expensive thing when a ship costing a million dollars has to spend two-thirds of its time lying idle while waiting to come up to the docks, as has often happened at the oil port of Batum; the charges for interest and depreciation, that is, for wear, rust, breakage, decay, and old age, count up almost as rapidly as if she were carrying merchandise, while the wages of the crew also continue. Hence shipowners prefer to send their ships to places where abundant docks make it possible to receive cargoes directly from warehouses or from railroad trains which come alongside, so that their loads may be hoisted from the cars to the ship's hold. Boston is an example of a great port which has suffered from lack of docks in the past, although now this is being remedied. New York, on the other hand, has perhaps the best dockage facilities in the world. Counting all the little bays and estuaries New York Harbor has a water frontage of 771 miles, 290 of which have been improved.

(*c*) *How Land for City Building Affects the Value of a Harbor.*—If a harbor does much business it must have a large city beside it. Such a city needs level land, especially for its business sections. Some cities such as San Francisco have grown great in spite of the hills, but those like Philadelphia, which have plenty of level land, are fortunate. So necessary is this that in many places shallow bays have been filled to make artificial land. The best residential section of Boston is the Back Bay, where once the tide ebbed and flowed. It paid Seattle to spend millions of dollars to cut down a steep hill of gravel in the heart of the city. By means of great streams of water squirted against the hill it was washed into the shallow part of the bay. Thus level land was obtained both by cutting down the hill and by filling the bay.

(*f*) *How Lines of Inland Communication Make or Mar a Harbor.*—A modern seaport can become of much importance only when it is served by numerous lines of land transportation. Along the Pacific coast, for example, the twin ports of San Francisco and

FIG. 39.—The Italian Town of Porto Fino.

Note how the waterfront attracts the houses, and how the hillsides have been terraced.



*By courtesy of the Bush Terminal Co.*

FIG. 40.—Bush Terminal, New York City.

**The demands of ocean transportation call for hundreds of miles of waterfront like this to accommodate the business of a single great city.**

Oakland are greatly helped because the combined Sacramento and San Joaquin valleys enable railways easily to reach the interior of California. Northward to the mouth of the Columbia River, on the other hand, no great city could grow up even if there were a good harbor, because high mountains everywhere hinder communication with the interior.

(g) *How the Hinterland Determines the Trade of a Harbor.*—A harbor has little value unless it has plenty of business. Business depends not only on the seaport itself, but on other places which are tributary to it. The region where such places are located is called the "hinterland." The importance of a hinterland depends not only on its size, but much more upon the number of inhabitants and their power to produce goods and to buy. Para is a seaport of minor rank, because its hinterland, the enormous basin of the Amazon, is sparsely populated and undeveloped. Providence, on the other hand, is far more important because its very limited hinterland, even though it embraces little more than Rhode Island, is densely populated and highly civilized.

A limited hinterland hinders the growth of a port even though the harbor is excellent, as is illustrated by the experience of a ship called the *Minnesota*. When she was built she was the largest vessel flying the American flag. She was put in commission between our Pacific coast and Oriental ports. Unfortunately, however, she could not at that time get a full load without a long wait. This was so expensive that finally she was transferred to the Atlantic side. The trouble was that on the Pacific side the hinterland contained too few people to supply full cargoes at frequent intervals. The hinterland on the Atlantic side, however, was so much more populous that it easily employed this ship and many others.

*How a Great Harbor was Made in an Emergency: Brest.*—The importance of most harbors is the result of gradual growth, but once in a while a harbor suddenly becomes great because of some emergency. For instance, Gary, at the southern end of Lake Michigan, suddenly became a considerable port when the United States Steel Corporation established its plant there. The most striking example of this kind, however, is Brest in western France, at the end of the peninsula of Brittany. Before the Great War Brest was a comparatively insignificant port to which there came only one ship for every two hundred that came to Le Havre, near Paris, at the mouth of the Seine. Of the seven requirements for a good harbor Brest had only three. It was protected from winds and waves because it lies at the inner end of a deep gulf 14 miles long; for this reason it had abundant anchorage space; and there was plenty of space for docks because the coast of Brittany is submerged, so that it is long and winding.

In all other respects the harbor was far from first class: the water was not deep enough for large vessels either in the channel or close to the shore where docks would have to be made; there was little level land for the growth of a city, for the hills rise steeply so that in many cases the ascent from the lower to the upper town has to be made by means of flights of steps, and the second or third story of one house is often on a level with the ground floor of the next. Moreover, the lines of communication with the interior were only moderate, for the one direct railway to the interior of France winds greatly among the hills of Brittany and is not adapted to heavy traffic. Finally Brest had only a small hinterland, for the ports of Nantes on one side and Cherbourg and especially Le Havre on the other are so much nearer the main centers of France that Brest had only a part of Brittany as its hinterland.

When the United States entered the Great War in April, 1917, these other ports were so busy with the shipping of France and England, and it would have been so difficult to enlarge them, that this country decided to convert Brest into a first-class harbor. Moreover Brest is the French port nearest America, and hence ships ran less danger from submarines in reaching it than in reaching more distant ports. Accordingly machinery of all kinds was at once sent over and thousands of soldiers fell to work with unbounded energy and enthusiasm. Great dredges scooped out a channel deep enough for the largest ocean liners. Huge docks of concrete were constructed with deep water alongside of them, and with railway tracks, cranes, and warehouses upon them. Space for camps, machine shops, and munitions works was obtained by going back onto the level plateau beyond the town and by running automobile lines to places that had hitherto been thought too far from the shore.

In addition to all this work directly on the harbor and port, the railway lines to the interior were much improved. All this was worth while, because Brest had suddenly acquired a great hinterland —the entire area where the American Army with its ceaseless demands for food, guns, projectiles, camp supplies, and men, was helping to win the war for the freedom of nations. By the spring of 1918 Brest had all seven of the requisites of a great seaport and soon became one of the world's busiest harbors. Nowhere else in all the world have nearly 300,000 men ever landed at any one port in a month. So great was the work of caring for the freight and passengers that passed through the port that the population increased many thousand. Then when the war was won, the Americans went away and the hinterland was reduced once more to a part of Brittany. In the other six respects Brest still ranked high among French ports, but the population soon began to diminish. Brest is too far from Paris and the other great centers of population and hence has too small a hinterland to retain its position as a really great port.

**Why Seaports Grow.**—Just as Brest had to expand suddenly to accommodate the workers who flocked in to make it a great port, so every seaport grows more gradually to accommodate similar workers. These provide a market for other people who sell food, clothing, and other necessities; still others serve as clerks, stenographers, teachers, masons, shoemakers, mechanics, and the other kinds of workers who are needed in every large community. Thus a city arises beside the harbor.

Such a city, whether it be a port on the ocean like Baltimore, on a lake like Buffalo, or on a river like New Orleans, possesses several advantages. For the manufacturer many kinds of raw materials are cheaper and are found in greater variety there than elsewhere, while it is relatively easy to build up foreign trade because the representatives of foreign business houses come to seaports much oftener than to cities in the interior. The merchant also prefers a seaport because it puts him in such close contact with the markets of the world. The people who are chiefly interested in art, music, science, or other intellectual pursuits prefer the seaports because so many travelers come to them, and thus those who live in the seaports are stimulated by personal contact with people who bring new ideas from other lands. When once a seaport, or a port on a lake or river, is well started it grows in spite of itself.

**Concentration of Population in Seaports of the United States.**—The remarkable way in which transportation by water influences the size of cities is shown in the following table:

RELATION OF CITIES OF THE UNITED STATES TO TRANSPORTATION BY WATER

| Population 1918. | Number of Cities. | Percentage Reached by Ocean and Lake Transportation. | Percentage Reached by River or Canal Transportation. | Percentage not Reached by Water Transportation. |
|---|---|---|---|---|
| | | Ocean Lake | | |
| A. Over 350,000 | 20 | 75 (50+25) | 25 | 0 |
| B. 100,000 to 350,000 | 55 | 31 (25+ 6) | 29 | 40 |
| C. 50,000 to 100,000 | 67 | 30 (27+ 3) | 22 | 48 |
| D. 25,000 to 50,000 | 128 | 25 (17+ 8) | 20 | 55 |

This table means that all of the twenty largest cities in the United

States have water transportation. Ten are reached by ocean-going vessels; five are on the Great Lakes, and the other five on the Mississippi or Ohio. One of these twenty, however, that is, Los Angeles, made its growth without the help of navigation, but felt the need of being a seaport so strongly that it reached out 20 miles and built a harbor at San Pedro, so that it is now a seaport. Washington, also, does not owe its growth to water transportation, but is included among the seaports because it is located on the Potomac estuary. In the United States thus far no city has risen to the first rank unless it is on the ocean or Great Lakes, or else on the Mississippi or one of its main tributaries. Yet the amount of land within five miles of these bodies of water is less than 3 per cent of the entire area of the country.

In the second line of the table we see that among cities of the second class with a population of from 100,000 to 350,000, about a third are on the seacoast or on lakes, another third on navigable rivers or canals, and the remaining 40 per cent have no water communication. With cities of the third class having from 50,000 to 100,000 people about a third are on the coast, while a quarter are on rivers or canals, and nearly half are not favored with water transportation. Finally only a quarter of the little cities of the fourth class with from 25,000 to 50,000 people are on the coast, while more than half have no relation to the water. If our table included the hundreds of still smaller towns with from 10,000 to 25,000 people, the proportion not reached by water transportation would be still greater, while with places having less than 10,000 more than 95 per cent are neither on the coast nor on navigable waterways.

**Concentration of Population in Seaports throughout the World.**— Not only in the United States, but in all parts of the world the demands of commerce cause the greatest cities usually to be located beside the sea. Of the 40 largest cities in the world, 23 can be reached by ocean steamers, and 2 by those plying on the Great Lakes of North America. Even among the 15 interior cities 7 are located on large navigable rivers such as the Mississippi, Danube, Vistula, and Nile, 3 are on small navigable rivers of no great importance, such as the Seine, Spree, and Oka, and only 5 are wholly without communication by water.

These facts, like those shown in the table for the United States, indicate that there is a great concentration of large cities on the coasts of oceans and great lakes. As time goes on this concentration increases, for it is the logical result of the growth of manufacturing and commerce and the establisment of closer relations among the nations. But to accommodate more commerce the seaports must have more docks, bigger ships, deeper channels, and more offices and warehouses, while more railway trains must pull into the great terminals. Hence the big seaports and lakeports grow more and more huge, so that some like New York can scarcely find room for all their buildings.

**Oceans and Civilization.**—Year by year the commerce carried upon the ocean grows more important. The lines of steamship traffic are like arteries and veins which carry life wherever they go. Merchant vessels break down the barrier of the sea, and open the seaboard parts of the world to the influence of all the other parts that have harbors. The more the life of the nation depends upon them, the more important it becomes that they should not be destroyed by calamities like the Great War.

Before man became civilized the sea and the other great bodies of water played almost no part in his life, except to regulate the rainfall and temperature of the lands, to furnish fish for food, and to prevent his migrating in certain directions. To-day the navigable waters are of supreme importance, for they enable the distant parts of the earth to contribute to one another's support; they are one of the conditions of the growth of our largest cities; they enable civilization and commerce to spread to all parts of the globe; and their control enables a nation to develop without fear of being overcome by its enemies.

## QUESTIONS, EXERCISES AND PROBLEMS

1. Make a table of the forty largest cities of the world in order of size, beginning with the largest. Opposite each put first the population in thousands as found in the latest year book, like the Statesman's Year book or the World Almanac, and then the class of transportation by which the city is reached; i.e., (*a*) ocean transportation, (*b*) lake transportation, (*c*) river or canal transportation, or (*d*) no water transportation. Now see if the proportions are the same as when this book was printed by comparing your figures with those on a preceding page.

2 Do the same as suggested in Exercise 1 with the cities of the United States with a population of more than 350,000.

3. Describe the harbor nearest your home, or some other in which you are interested, in respect to the seven conditions discussed in this chapter. Point out in which conditions it excels and in which it is deficient. Organize the whole into a problem with this form. Why has....................become such an important seaport? Or why has not ....................become more important as a seaport? Let each of the seven conditions take the form of minor problems, such as, How has the protection which the harbor furnishes vessels helped (or hindered) the growth of.......................................

4. How does the interior location of Czecho-Slovakia handicap that country?

5. In the following table of water-borne commerce of some of the world's chief ports, select any pair of ports on the same horizontal line and put them into a problem as follows: "Why has ........become so much more important as a seaport than......................? Compare them as to each of the seven

qualities mentioned in this chapter so far as you can find the facts in encyclopedias. geographies, and other books.

VALUE OF THE WATER-BORNE COMMERCE OF SOME OF THE WORLD'S CHIEF PORTS

| | | | | | |
|---|---|---|---|---|---|
| New York | (1917) | $4,390,000,000 | Boston | (1917) | 420,000,000 |
| London | (1916) | 2,666,000,000 | Cardiff | (1916) | 110,000,000 |
| Liverpool | (1916) | 2,317,000,000 | Manchester | (1917) | 431,000,000 |
| Hamburg | (1913) | 1,902,000,000 | Belfast | (1916) | 50,000,000 |
| Antwerp | (1912) | 1,211,000,000 | Bordeaux | (1913) | 168,000,000 |
| Marseilles | (1913) | 755,000,000 | Bilbao | (1913) | 32,000,000 |
| Havre | (1913) | 617,000,000 | Southampton | (1916) | 82,000,000 |
| Montreal | (1917) | 606,000,000 | Quebec | (1917) | 32,000,000 |
| Philadelphia | (1917) | 574,000,000 | Vera Cruz | (1913) | 83,000,000 |
| Bremen | (1913) | 582,000,000 | Rio de Janeiro | (1916) | 134,000,000 |
| Genoa | (1915) | 509,000,000 | Naples | (1915) | 123,000,000 |
| Buenos Aires | (1916) | 440,000,000 | Valparaiso | (1916) | 38,000,000 |
| Calcutta | (1916) | 454,000,000 | Bombay | (1916) | 187,000,000 |
| Yokohama | (1916) | 353,000,000 | Antofogasta | (1915) | 31,000,000 |
| Kobe | (1916) | 352,000,000 | Canton | (1916) | 67,000,000 |
| Sydney | (1916) | 351,000,000 | Alexandria | (1916) | 284,000,000 |
| Hull | (1916) | 422,000,000 | Tampico | (1913) | 63,000,000 |
| Glasgow | (1916) | 369,000,000 | Havana | (1916) | 272,000,000 |
| Trieste | (1913) | 337,000,000 | Fiume | (1912) | 98,000,000 |
| New Orleans | (1917) | 408,000,000 | Santos | (1916) | 170,000,000 |
| Baltimore | (1917) | 400,000,000 | Callao | (1916) | 62,000,000 |
| Seattle | (1917) | 370,000,000 | Montevideo | (1911) | 75,000,000 |
| Shanghai | (1916) | 349,000,000 | Tientsin | (1916) | 54,000,000 |

6. Contrast your home State with an interior or coast State of the same latitude in respect to the average January temperature as given in any encyclopedia. In respect to the average July temperature. How do you explain these contrasts?

7. Why is farming so thriving in Great Britain while in Labrador in the same latitude it is practically impossible?

8. If there were no oceans why would it be impossible for man to carry on farming in the vicinity of interior bodies of water like the Great Lakes?

9. If you had your choice between a visit to an emerged or a submerged coast for a summer vacation which would you choose? Why?

10. Give three advantages that are enjoyed by a city on a coast of submergence that are denied an interior city.

11. (*a*) What is the chief fish taken in each section listed in the table entitled "Fisheries in the United States" in the *World Almanac?*

*b.* What is the tonnage of the average boat engaged in fishing in each section of the country?

*c.* Why are the Alaskan vessels far larger than any others?

*d.* Why do the New England vessels come next?

*e.* Determine roughly the number of persons employed per vessel, and compare this with the size of the vessels.

*f.* On the Mississippi River and its tributaries how does it happen that although the thirty-nine fishing vessels have an average size of only seven tons, there are over 250 fishermen to each vessel?

*g*. State all the reasons why the New England States are still the great school of sailors in spite of the fact that their fisheries employ fewer men than do those of other sections?

*h*. Why is the value of the New England catch of fish almost as great as that of the Middle Atlantic States, where twice as many boats and over twice as many men are employed?

*i*. Why is the value of the Alaskan catch nearly half that of the whole country?

12. *a*. On an outline map of the world insert in their proper places the figures given in the accompanying table showing the annual value of fishery products per person.

*b*. What country or section shows best the effect of high latitude on fisheries? The effect of low latitude?

*c*. What region shows best the effect of a long irregular coastline and a sparse population? The effect of a short regular coastline and a dense population?

*d*. What region shows best the effect of broad shallow seas adjacent to the coast? Of neighboring seas of great depth?

*e*. Why do Japan and England rank relatively low in the table, although they are important fishing regions?

*f*. Why does Alaska head the list?

*g*. Why does Denmark rank so much lower than Iceland?

*h*. Why does Germany fall near the bottom?

*i*. Explain why Italy and Ireland with their long seacoasts catch so few fish.

## APPROXIMATE ANNUAL VALUE OF FISHERY PRODUCTS PER PERSON

| | | |
|---|---|---|
| Alaska | (1917) | $800.00 |
| Newfoundland | (1914) | 40.00 |
| British Columbia | (1917) | 30.00 |
| Iceland | (  ) | 25.00 |
| Maritime Provinces of Canada | (1917) | 17.00 |
| Norway | (1913) | 6.00 |
| Scotland | (1916) | 3.50 |
| New England | (1908) | 2.50 |
| Pacific States | (1915) | 2.00 |
| Denmark | (1914) | 1.50 |
| Portugal | (1914) | 1.50 |
| Japan | (1911) | 1.10 |
| England and Wales | (1916) | 1.00 |
| France | (1913) | 1.00 |
| Holland | (1912) | 1.00 |
| Middle Atlantic States | (1908) | .80 |
| Spain | (1914) | .60 |
| Gulf States | (1908) | .50 |
| Ireland | (1915) | .30 |
| South Atlantic States | (1908) | .30 |
| Germany | (1913) | .15 |
| Belgium | (1912) | .15 |
| Italy | (1913) | .10 |
| Mississippi Valley States | (1908) | .10 |
| India | | .05 |

13. Give the five chief reasons why it is possible for steamships to compete successfully with railroads in carrying freight between New York and San Francisco.

14. In the *World Almanac*, look up the tonnage of the vessels in the chief countries of the world. By using a table of population, find out how much the tonnage amounts to per million inhabitants. On an outline map of the world insert the figures thus obtained and shade the map to show four grades. Contrast the countries in the highest grade with those in the lowest in respect to conditions described in this chapter as promoting ocean commerce.

15. In order to prepare for the study of climate in a later chapter, begin a weather record as indicated in Exercise 1, Chapter XII. Also, secure copies of the daily weather map for the next three or four months. Study these to see whether you can detect any influences of continents and oceans.

# CHAPTER VI

## THE USE OF INLAND WATERS

THE most important inland waters comprise lakes, both salt and fresh, rivers, and canals. Like the oceans, these serve as (1) regulators of temperature, (2) sources of moisture, (3) as an aid to health, (4) as a source of minerals, (5) as a source of food, (6) as barriers, and (7) as carriers of commerce. They also serve as (8) sources of water supply, (9) as a source of power, and (10) as a means of irrigation, fertilization, and drainage. This last pertains so largely to agriculture that it is deferred to Part IV.

**Inland Waters as Regulators of Temperature.**—As regulators of temperature even the largest lakes are of little importance compared with oceans. Yet the southeastern shores of Lakes Michigan and Erie are great regions for grapes and other fruit because the water, which retains the heat of summer in the fall, warms the northwest winds and prevents early frosts. Also in the spring the lakes retain the low temperature of winter and thus prevent the fruit trees from flowering too early and being nipped by the frost. In the same way Chicago is a much more healthful and vigorous city because in summer the hottest days are often relieved by lake breezes which blow like sea breezes in the afternoon. Even a small lake or a broad river has a slight cooling effect on the wind in summer and a warming effect in the autumn, when the water does not grow cold so fast as the land.

**Inland Waters as Sources of Moisture.**—In this respect lakes and rivers are no more important than as regulators of temperature. Nevertheless at the southern end of the Caspian Sea the northern slopes of the Elburz Mountains are very well watered by rain derived from this great salt lake, and form a striking contrast to the barren deserts on either side. The Caspian Sea, however, is so large as to be almost like a part of the ocean, and the high mountains at its southern end would cause rainfall even if it were dry. An inland body of water as large as Lake Michigan receives only a little more rain on its eastern or leeward side than on the windward side. Smaller lakes have practically no effect on rainfall.

**Inland Waters as Aids to Health.**—When it comes to health and recreation inland waters take high rank, although not so important as the ocean. How high they stand is evident from the way in which little summer houses skirt the shores of lakes, ponds, and rivers all over the United States. The boy who goes to the swimming hole on a hot summer day is illustrating the importance of inland waters in this respect. So, too, is his sister who takes her sewing down by the river to enjoy the cool breeze, and his college cousin who goes to Canada on a canoe trip. Few summer resorts are more famous than those around the Rangeley Lakes, at Lakes Champlain, George and Placid, and along the shores of the upper peninsula of Michigan. The Thousand Isles in the picturesque St. Lawrence River are equally noteworthy, as are Lakes Louise and Tahoe in the western mountains.

**Inland Waters as a Source of Minerals.**—Fresh-water lakes and rivers do not furnish minerals, but other inland bodies of water are a source of medicinal salts, iron ore, peat, salt, and potash. Many springs like those of Saratoga are full of dissolved minerals which have a most valuable healing quality. Swamps are the source of bog iron ore. To-day this is not important, but the first iron foundry in America was established at Lynn in 1643 to smelt the ore from neighboring bogs. Swamps also furnish peat, which may be called a half mineralized vegetable product. Most of the world's coal appears to have been formed in ancient swamps which were part of the earth's inland waters. Salt lakes also furnish not only rock salt, such as is obtained by evaporating the water in little ponds on the shores of the Dead Sea, but also rarer minerals, such as potash, which is found abundantly in many little lakes in western Nebraska. Many important salt deposits such as those deep down in the earth near Syracuse, N. Y., were laid down millions of years ago in salt lakes that were gradually drying up.

**Inland Waters as Sources of Food.**—Most of the stories of fishermen are based on the experiences of amateurs in inland waters. In spite of all the stories, however, the amount of food procured in this way is small. This is largely because in most inland waters the supply of fish is too small to tempt professional fishermen. The fish are caught by amateurs who go fishing only a few times each year. Nevertheless some rivers like the Illinois and some of the larger lakes support far more fishermen in proportion to their size than do the seas. These men and those who catch salmon and other fish at the mouths of rivers entering the sea procure two-fifths of the whole catch in the United States. In Russia, also, the Volga, Don, and other rivers support very extensive fisheries, the most famous of which are the sturgeon fisheries, where caviar, or sturgeon roe, is procured.

**Inland Waters as Barriers.**—The importance of inland waters as barriers is even greater than that of the oceans. Every person who reads this book has probably been put to inconvenience hundreds of times because of some comparatively slight water barrier. Perhaps it was only a brook across which it was necessary to jump. Or perhaps it was a river which made it necessary to go several blocks out of the direct route to reach a bridge or ferry. The reason why inland waters are more troublesome than the vast water barrier of the ocean is, their small size and great number. Because they are small, one can rarely travel far on them in the right direction. Because they are numerous, frequent bridges are necessary along most routes, or else one must keep changing from land transportation to water transportation.

**The Mississippi River as a Great Water Barrier.**—The Mississippi river illustrates many of the ways in which inland waters serve as barriers. On the map notice how largely this great river forms the boundary between States. This is natural, for the stream is so wide, so deep, and so subject to great floods that it is very difficult to cross it in boats or to bridge it. Until Memphis is reached, 500 miles upstream there is no bridge, and of the two there only one is passable for wagons. The next bridge is near Cape Girardeau, 175 miles farther up, and the next at St. Louis, 125 miles still farther. Not till St. Louis is reached, over 800 miles from the Gulf of Mexico, or 1270 as measured along the windings of the river, is there a second bridge which can be crossed by wagons and foot passengers as well as by trains.

In order to realize the importance of the Mississippi barrier, consider how many delays it causes. Even where a ferry is close at hand, it is a slow way of travel. At New Orleans, for instance, all railroads connecting with the west have to run their trains on to ferryboats. This takes *time*, for the cars have to be shunted back and forth, the ferryboat moves slowly, and the landing stage must be raised or lowered so that the tracks on the land and on the boat meet exactly. Moreover, the loss of life on the river, the extra effort involved in crossing it, and the long delays all cause *expense*, and so does the building of boats, bridges, and tunnels, so that every water barrier is a great consumer of money.

To sum it all up, the chief reason why the Mississippi and other bodies of water are barriers is that they require a *change in the mode of traveling*. The train must run on an expensive bridge or ferryboat instead of an ordinary track; the pedestrian must swim or get a canoe or other boat. The change is what makes the trouble, for when a man or a piece of freight is once aboard the boat it is a cheap and easy means of conveyance. The man who keeps a motor boat on the banks of the Mississippi has the means of overcoming the water barrier almost as effectively as his automobile overcomes distance on the land.

**How Water Barriers Determine the Location of Cities:** *London.*—Since bodies of water act as barriers, the places where it is easy to cross them are likely to develop into towns. This is because roads converge at such places, and people are often obliged to stop there. London is a good example. Ten or more centuries ago the most important part of England was the southeastern corner. The next most important part was the region north of the lower Thames, and south of the curious square-cornered indentation called "The Wash." The silk merchant who went from Cambridge to Paris, for example, or the pilgrim who was returning from Rome to Norfolk, was obliged to cross the Thames, or else go around its head. The lower reaches of the river were not easy to cross because the stream widens toward the sea and is bordered by marshes. Hence traffic converged at the lowest point where the stream is narrow and the banks are firm, and there London grew up. Its site was where the water barrier could be easily crossed. That is why London Bridge, at the point where the river was first easily crossed, is one of the world's most famous structures.

Of course other factors helped to cause London to become so great, for the city lies at the head of ocean navigation on the Thames, and the Thames estuary faces two other estuaries—those of the Scheldt and the Rhine. In our day the people of London do not think much about the Thames as a barrier. Nevertheless they often have to go out of their way to get across the river, even though there are fourteen passenger bridges, one ferry, and four tunnels. These facilities for ordinary traffic, aside from the railways, cost between thirty and forty million dollars, and the cost of maintaining them and of paying interest on the original investment is about two million dollars a year. The Thames is still a costly barrier.

**Other Cities.**—Paris, at the little Isle of Orleans, where the Seine is easily crossed, is another city whose location was originally determined by a river acting as a barrier. The city has grown great because it lies near the center of a rich agricultural region known as the Paris Basin. So prosperous a region needs a city of considerable size as its center, but aside from the island which helps to overcome the barrier of the Seine and which at one time served as a stronghold protected by water, there is little reason why the city should be located at one place rather than another. In the same way Cairo is located at a point where the Nile begins to divide into the many branches or distributaries of its delta, and hence where an important ferry is maintained, since it is easier and cheaper to maintain one large ferry than many small ones. Chicago's growth in the first favorable location west of the southern end of Lake Michigan is due to the fact that the lake is a barrier. All the traffic from the North Atlantic States to Wisconsin, Minnesota, and the Dakotas must converge at the lake's southern end, and hence a great railroad center had to grow up there.

**The Expense of Water Barriers:** *New York City.*—The city of New York, unlike London and Paris, owes its location not to water barriers, but to the excellent water communication with which it is provided. The very water which affords such good means of communication with Europe and other far-away places, however, is very troublesome as a hindrance to local communication. This is because New York is built on *islands*. Manhattan Island and Long Island contain more important parts of the city than the mainland. While the city was small the so-called "rivers" which separate the islands and the mainland caused little trouble, for few people made journeys out of town. In time, however, the lower end of Manhattan became thickly covered with buildings. Thereupon the price of land began to rise. People who were planning new business enterprises did not want to locate beyond the water barriers, but were willing to pay high prices for land near the center of the city. Accordingly to-day in some parts of New York a single square foot of land is worth over $1000. A piece the size of an ordinary school desk is worth about $5000. From the mere rent of an area the size of five desks the owner could get much more than the average wages of a laborer, or enough to support a family in moderate comfort.

When land became so valuable people began to try to overcome the difficulty due to the water barrier by erecting higher and higher buildings. New York has now more than 200 over fourteen stories high. The lowest of these tower about 200 feet, while the highest, with fifty or more stories, rise 700 feet, and some accommodate about 15,000 workers. The streets between them are like deep canyons, so gloomy that rents in their lower stories have decreased. When the elevators cease to run, as has sometimes happened during a strike, some of the workers are actually unable to climb to their offices, or take half an hour to do it.

While the sky-scraper type of architecture was being developed as one response to the water barrier, a great many ferries were coming into existence as another response. Thus large numbers of people were able to build homes in Brooklyn or on the Jersey side of the Hudson, where land is relatively cheap and the surroundings pleasant. On this account the ferry system grew to such proportions that there are now over forty lines. The railroads, too, except those now known as the New York Central, and the New York, New Haven & Hartford, had to carry their passengers and freight to the city by boat.

In addition to all this the New Yorkers, in their desire to overcome the water barriers of their island home, have built five huge bridges to Brooklyn at the enormous expense of $90,000,000. They have also dug tunnels under the rivers, five to Brooklyn and three to the Jersey side. The cost of the ferries, bridges, and tunnels, by which New York overcomes the water barriers, must have been as much as a billion dollars. Every year the interest on this amounts to $10 for every man, woman, and child in the city. Although the water of New York's harbor is one of the chief causes of the city's greatness, the water between the different parts of the city is a most expensive hindrance.

**Inland Waterways as Carriers of Commerce.**—Inland waterways, including rivers, canals, and lakes, are especially important as carriers of commerce in backward countries like China, Siberia, and northern Brazil, which possess large rivers, but have not a highly developed railway system. They are also important in advanced countries like Holland and Germany, where numerous rivers flow through densely populated plains. Nevertheless, in view of the cheapness of water transportation, the use of inland waterways is by no means so great as would be expected. This is because a good inland waterway must be favorable in each of the following respects, all of which are rarely satisfactory in a single body of water: (1) depth and breadth; (2) length; (3) character of the course; (4) current; (5) seasonal changes; (6) hinterland; and (7) direction.

(1) *Depth and Breadth.*—These two qualities are closely connected and both depend largely on volume. If a river comes from a region of heavy rainfall it is likely to have great volume and hence to be deep enough and broad enough for important traffic. The Amazon is such a river. For a distance of 2300 miles its vast volume causes it to average 120 feet deep and to have a width of more than a mile and often five or six. So vast is the river that while a ship is still beyond sight of land the sailors sometimes let down buckets and draw up fresh water from what seems to be the ocean, but is really the enormously wide mouth of the river. Cases have actually been known where sailors have died of thirst when adrift on the fresh water at the mouth of the Amazon.

The Rio Grande illustrates the opposite condition. Although it is half as long as the Amazon, it is practically unused for navigation. It comes from a region of such sparse rainfall that it has little volume and hence very slight depth. Even at its mouth it is shallow, and higher up it sometimes is dry. On almost all rivers the presence of sandbars at the mouth and of other shallow places higher up is one of the chief hindrances to navigation.

(2) *Navigable Length.*— The length of the navigable stretches on a river is of the first importance. The Yangtse, for example, is navigable for 1000 miles in one continuous stretch from its mouth far into the heart of China. This makes it of great value for commerce. The Orange River, on the contrary, although it has an actual length of 1300 miles, is of no value for navigation, because the stretches where boats can ply extend only a few score miles. It would never pay to ship goods fifty miles by boat, then thirty by rail, again one hundred by boat, once more by rail, and so on. The reason is that trans-shipment is very expensive. With some kinds of freight it actually costs more to load a ton onto a steamer and take it off again than to carry it all the way from New York to Liverpool, and even with kinds that can be loaded inexpensively a single loading costs as much as scores of miles of actual transportation. Hence no waterway is of much use for commerce unless its navigable reaches are long and uninterrupted.

(3) *Character of Course.*—Straight rivers like the Amazon, Hudson, and St. Lawrence are far the best for navigation. On rivers with winding courses not only are distances much increased, but the channel is almost sure to wind still more, so that little speed can be made, and there is danger of running aground. On the Mississippi, which has an extremely winding course, some of the meanders or bends are so extreme that after flowing ten or fifteen miles around a horse-shoe curve the stream comes back to within a few hundred yards of its earlier position.

(4) *Current.*—The more gentle the current of a river the better it is for navigation. The great Volga River, even at its source, is only 665 feet above sea level, while 1500 miles from its mouth it is only 190 feet above the level of the ocean and 280 above the Caspian. Hence throughout most of its course the current is so gentle that ships are little impeded and locks and dams are unnecessary. Contrast the Volga with the Brahmaputra, which rises 15,500 feet above the sea, and flows so swiftly over rapids and falls that along much of its course no one has ever used a boat. The Zambesi is another great river, along which numerous rapids, in addition to the great Victoria Falls, divide the navigable water into sections too short to be of much use. The other great African rivers suffer the same disadvantage. Even the Nile, which has 2900 miles of uninterrupted navigation at high water, is at most seasons broken into many sections by rapids, or cataracts, as they are called.

(5) *Seasonal Changes.*—Practically every river is subject to strong seasonal changes. Floods and droughts are more or less universal, while freezing is common. The rivers most free from floods come

from great lakes, as in the case of the St. Lawrence, or receive an abundant supply of rain at all seasons, as is the case with the two greatest equatorial rivers, the Amazon and Congo. The rivers of Siberia have the disadvantage not only of floods, but of ice. In the winter the Amur, for example, is frozen for six months; then when the ice breaks up, great floods occur and would wash away not only the shipping, but the floating docks, which are the only kind possible, if these were not all safely moored in harbors of refuge. Later, however, in May and June, the floods make navigation easy, since the shallows are deep and the rapids smooth. Finally, in the fall before the river freezes up, it falls so low that ships are greatly hampered by the danger of running aground.

(6) *Hinterland.*—Even if an inland waterway were ideal in other respects, it would not carry much commerce unless it had a well-populated hinterland able to supply raw materials, food, or manufactured goods in exchange for products brought from afar. Compare the Danube and the Yukon. The Danube flows through some of the most densely populated and progressive parts of the world. Hence it carries thousands of boats of all sizes from small ocean steamers and large canal barges down to rowboats. So far as natural advantages for navigation are concerned, the Yukon is little inferior to the Danube except for the long frozen period from October to April. Nevertheless, it does not carry one boat for a hundred on the Danube, for its hinterland contains only a few miners who do not consume much, and do not furnish any articles of export in quantities large enough to supply cargoes.

(7) *Direction.*—The direction is the one feature of inland waterways which man cannot control. He can deepen and broaden a river, or increase the navigable length and overcome falls and rapids by building canals and locks. He can straighten windings, control the current, overcome the effects of seasonal changes, and populate the hinterland, but he cannot change the general direction in which a river flows. Yet this condition is the most important in determining the value of an inland waterway. The Rhine is a relatively small river, but because it flows toward the place where England nears the continent, and where are located Rotterdam, Antwerp, and London, it supports an incredibly active commerce. The MacKenzie and the Ob are far larger than the Rhine, but in a year they carry no more commerce than the Rhine does in a day, for they flow toward the frozen north instead of toward the places where trade and manufacturing are active.

**The Good Inland Waterway of the St. Lawrence and the Great Lakes.**—Let us now take a few of the world's great systems of inland waterways and see how they stand in respect to the seven requirements mentioned above. The St. Lawrence River and the Great Lakes form one of the world's finest systems. They furnish a broad, deep, and relatively straight waterway penetrating about 1700 miles into the interior. There is some difficulty, however, because of the Lachine and Sainte Marie rapids and the falls of Niagara, but these have been partly overcome by canals and locks so that ships drawing 14 feet can go from the sea to Chicago or Duluth. Another and more serious difficulty is that although seasonal changes have no great effect upon the depth of the water, they cause the St. Lawrence River and the Great Lakes to be closed by ice for three months during the winter. Such difficulties, however, are more than compensated by the wonderful hinterland which includes the great grain regions of the central plains, the unexcelled iron deposits near Lake Superior, the immense coal mines of Pennsylvania, and the rich farm lands of New York and southern Canada. Moreover, throughout the Great Lakes region the direction of this great waterway is almost ideal, for it connects regions of three great types producing food, raw materials, and manufactured goods. Down the St. Lawrence the direction is also excellent so far as relations with Europe are concerned. It would be far better, however, if the river flowed to New York and the great markets on the Atlantic coast instead of to the barren coasts of Labrador and Quebec. This has made it advisable to dig the New York State Barge Canal, 362 miles long, which extends from Buffalo to Albany, where it connects with the Hudson River. This canal, however, is only 12 feet deep, so that neither lake nor ocean steamers can enter it, and trans-shipment is necessary at each end. For this reason it carries only one-fiftieth as many tons of freight as the Sault Sainte Marie at the outlet of Lake Superior. In 1920 the tonnage carried by the canals of New York State was only about a fourth as great as in 1880, but it is hoped that this will now rapidly increase.

**The Excellent Waterway of the Rhine and the German Canals.**— The system of inland waterways of which the Rhine is the main artery owes its importance to its hinterland and its direction. Because the Rhine flows through an extremely populous and progressive region and toward the center of the world's activities, the Germans and Dutch have found it worth while to deepen and broaden it; to increase its navigable length by canalizing certain parts; to straighten out the windings; to provide cables to pull ships up through the strongest currents; and to make provision for the regulation of floods. To take further advantage of this excellent waterway, the Germans have built many canals to connect it with the Weser, Elbe, and other rivers farther east. The canals greatly enlarge the hinterland, and enable

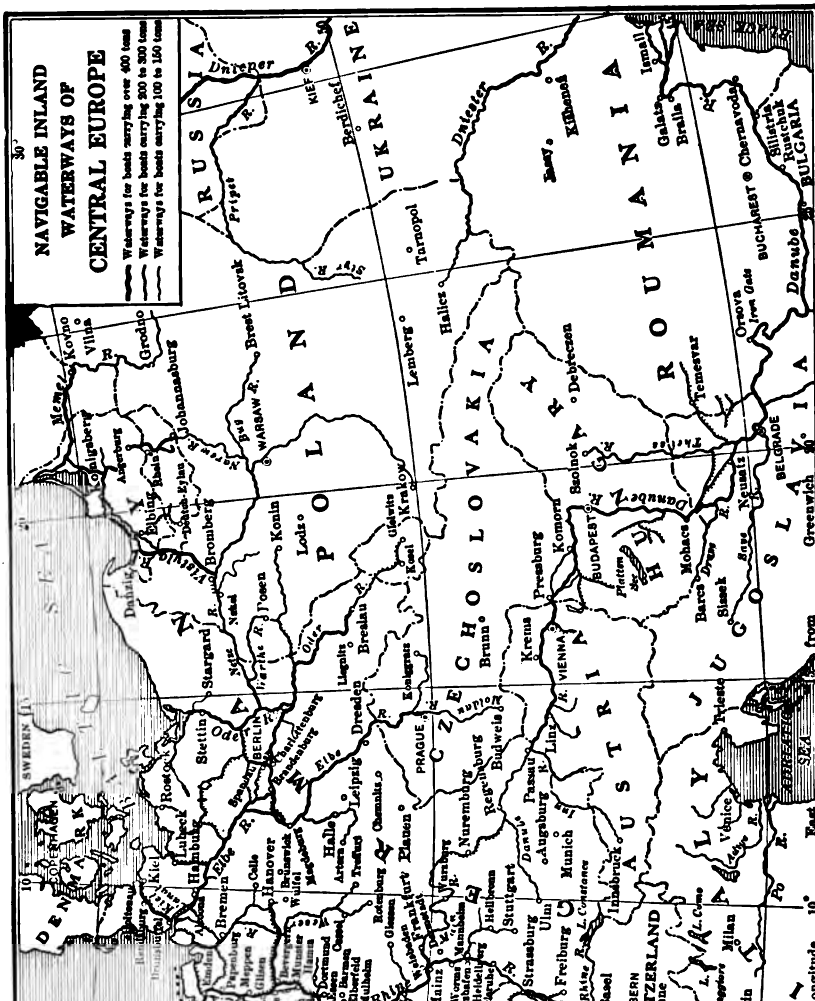



FIG. 41.—Map of European Waterways.

traffic to move east and west rather than in a more northerly direction along the line of the main rivers. Thus goods from the Vistula River can now be carried to Holland by inland waterways without breaking bulk. The Rhine and the German canals well illustrate the tendency of commerce to aim straight at the most thickly settled industrial regions. A detour to the Baltic Sea, where the surrounding population is much less dense than around the North Sea, is much like a detour down the St. Lawrence to Newfoundland.

**The Superior Inland Waterway of the Yangtse.**—The Yangtse River, more than any other inland waterway, fulfills all the conditions mentioned in this chapter. It is generally so broad and deep that even without artificial improvement ocean steamers of 6000 tons can usually reach Hankow, about 700 miles from the coast. In this stretch the windings are not particularly troublesome, and the current is negligible, for the river falls only an inch per mile. Although floods raise the river 40 or 50 feet at Hankow, they do not seriously hinder traffic. In fact, for these 700 miles, the advantages for navigation are little inferior to those of the Amazon, while the hinterland is far superior. Above Hankow small steamers can go another 300 miles to Ichang, where the river is still only 130 feet above sea level. Then rapids intervene for 350 miles, but so large is the river, so excellent its direction, and so rich and populous the Szechuan hinterland that much traffic is carried even here, while higher up the stream is again easily navigable.

Everywhere for nearly 2000 miles the Yangtse flows through a region full of industrious people, so that its hinterland is one of the best in the world. It contains more people than the entire western hemisphere. If ever these should become as energetic as those in the hinterlands of the Rhine and the St. Lawrence, ships might pass as frequently as at the Straits of Dover. The direction of the Yangtse is ideal, for the river runs through the heart of the most fertile part of China directly toward the part of the coast where the greatest cities are located and where trade is most active. The importance of the stream is still further increased by large navigable tributaries, the chief of which join the main stream near Hankow, and by the Grand Canal, which connects the mouth of the river with Tientsin and the great cities of the Hwang Valley.

**The Great Difficulty of the Mississippi Waterway.**—In proportion to its size and length the Mississippi River is used far less than the St. Lawrence, Rhine, and Yangtse. In fact, the tonnage carried by the Mississippi is less than that of many far smaller rivers like the Elbe. This is surprising in view of the many advantages of the river. The channel has a depth of 9 feet to St. Louis, 1270 miles from the mouth, whereas the Rhine has an equal depth for only a quarter as far, to Mainz. The length of the Mississippi is a wonderful advantage, for with its main branch, the Missouri, it constitutes the longest river in the world. The current is also comparatively favorable, for though it is rapid in places, the river falls only 4 inches a mile from St. Louis downward. Finally, the hinterland is ideal, for it includes the most fertile parts of the United States. Against these advantages stand two minor and one main disadvantage. The disadvantages of the many windings of the river's lower course and of the seasonal floods could be overcome without undue expense. The main disadvantage is the insurmountable drawback that the river does not flow toward the eastern manufacturing districts and Europe, which are the great markets for the food and raw materials of its rich hinterland. If the Mississippi flowed from St. Louis to Baltimore or Philadelphia many people believe it would pay to spend much more than the hundred million already spent in improving navigation, and the river might carry far more freight than any other inland waterway. Unfortunately, however, the Mississippi lies at right angles to the main lines of traffic. Thus, like the railroads that cross the continents from north to south, it cannot vie with lines of communication that run east and west. Only when the trade of the United States with South America and the Orient by way of the Panama Canal develops to large proportions will the great river come into its own as one of the world's main inland waterways.

(8) *Why a Large Water Supply is Needed.*—As people become more civilized, the need of a large water supply steadily increases. It is needed for three main uses: (1) domestic; (2) municipal; and (3) industrial. The domestic uses begin with drinking, which demands only about half a gallon per person each day on an average. Cooking requires a larger amount, while washing and bathing demand many gallons per day. To this must be added the water drunk by domestic animals, and that which is used for watering plants, gardens, and lawns.

The municipal uses include all that is needed for fire protection, public fountains and drinking places, street sprinkling, and the flushing of sewers. This amount varies from nothing in small villages to many gallons per person in large cities. In the same way the amount of water used for industrial purposes varies from nothing up to a quantity much larger than for the domestic and municipal purposes combined. It includes the water used for engine boilers, for condensing steam, and many special industrial purposes like washing cloth and cleansing hides.

For all these purposes together, an ordinary town in the United

States requires from 50 to 150 gallons of water per day for each person. Usually this supply is obtained so easily, by simply turning a faucet, that people do not realize how important it is. They feel the importance of the matter, however, when there comes a drought, as occurred in New England in 1911, and the lawns must be allowed to dry up, the taking of baths is restricted, and some of the factories have to shut down for a few weeks.

**What Kind of Water Supply is Needed.**—The quality of a water supply is even more important than its quantity. For that reason every up-to-date city employs skilled engineers not only to determine the best source of water and how it shall be protected from contamination, but also to construct purifying works if necessary and to test the water continually, to see whether it contains any harmful impurities. The requisites of a good water supply are as follows:

(1) *Freedom from Mud.*—Mud is a comparatively common evil, but does little harm. The people of St. Louis, for example, drink the muddy water of the Mississippi River. Now they filter it, but even before they had their great filtration plants, they found it wholesome. A little mud is harmful chiefly because it does not look attractive, and it is largely for this reason that cities build settling basins where the water stands still for some hours and drops its load of silt. In some cases, however, even a prolonged period of quiet will not cause the finest clay to settle, and some of the most wholesome water supplies are a little cloudy.

(2) *Freedom from Taste and Smell.*—Water that has a disagreeable taste or especially a distinct smell is undesirable. Often, however, what people call a disagreeable taste means merely a taste different from that to which they are accustomed. A smell is more likely to be a sign that something is really wrong. Yet neither taste nor smell necessarily indicates that the water is unwholesome, as many people in prairie towns are well aware. Nevertheless, since both are disagreeable, and since either may indicate that the water is bad, cities go to great expense in order to get rid of them, either by filtration or by chemical treatment.

(3) *Freedom from Chemical Impurities.*—Some chemical impurities reveal themselves by their taste or smell. A large number, however, such as the lime which causes hardness, do not make the water disagreeable, while some—such as iron—which produce both taste and smell, are beneficial. Lime is by far the most harmful of the common chemical impurities of water and the hardest to get rid of. When hard water is used in boilers it causes the deposition of a limy cake on the inside of the boiler and soon ruins it. In the same way, in man's body, it may increase the susceptibility to rheumatism, goiter, and

other diseases. Yet such water may be sparkling and clear, without odor, and with the most delightful taste.

(4) *Freedom from Bacteria.*—This is by far the most important quality of a water supply. Water that is ideal in other respects may contain the germs of typhoid fever, dysentery, and other diseases. The city of Niagara Falls has suffered greatly from typhoid because Buffalo discharges its sewage into Lake Erie and Niagara Falls takes its water from the Niagara River which flows from that lake. Even though the water seems to have become perfectly clear and has no mud, no taste, no odor, and no chemical impurities, the disease germs of Buffalo still live and do vast harm. In Europe the prevalence of typhoid germs in the water supply of many of the cities is one chief reason why wine and beer are used so extensively. In China, where disease germs are still more abundant in the water, the people almost universally drink tea. They have found by long experience that the best way to get rid of bacteria is to boil the water, a lesson which people ought to remember when obliged to use doubtful supplies of water or when typhoid and dysentery are common.

**How a Water Supply is Procured and Distributed.**—(1) *Primitive Methods.*—The simplest way of getting a supply of water is to dip it up by hand from a stream, spring, or lake. In Oriental countries like Persia, and in tropical countries like India and Venezuela, one can any day see scores of women walking gracefully to the stream or the fountain with earthenware jars poised on their heads or shoulders. Elsewhere men with plump goatskin bags on their backs or driving barrel-shaped little donkey carts bring water from the muddy river and fill the big earthenware pots that stand in a shady corner of every courtyard.

(2) *Ordinary Wells.*—Among civilized people and among many who are only partly civilized, wells are the most common source of water. This is because the soil and the solid rock are everywhere saturated with water below a certain depth. The varying level at which permanent water is found is called the *water table.* The water table is only a few inches below the surface in swamps, but generally several hundred feet in deserts. Wherever a well is sunk it must go deep enough to penetrate below the lowest level to which this table falls in dry seasons. The chief difficulty with wells is to raise the water to the surface. In many places this is done by hand with long ropes. In parts of tropical Mexico long lines of women come to the wells in the cool of the morning long before sunrise and wait their turn in order to pull up water from a depth of a hundred feet or more. Often, however, this work is done by horses, oxen, or camels. In Mexico the well rope is sometimes fastened to the horns of an ox, or to the saddle

of a horse, where it causes a great and unnecessary strain which soon kills the animals. These primitive methods, however, are fast being replaced by machinery. The simplest machine for drawing water is the hand pump, but pumps run by animal power, by wind, and by gasoline are also largely used. The use of such power pumps usually leads to the building of tanks or reservoirs, and thus makes it easy to have running water in the house at all times. This is a great advantage, for the easier it is to get water the more likely people are to use it, not only for drinking and cooking, but also for bathing, washing, and fire protection. Moreover, such a water system is a great help in insuring purity.

(3) *Artesian and Driven Wells.*—The use of machinery has made it possible to drill wells of great depth. Artesian wells are those in which the well penetrates to porous layers of rock lying between impervious clayey layers. The layers must be tilted sufficiently, so that part of the porous layer will reach the surface at a point higher than the top of the well. In that case, the water will flow out of the well and even gush out, as at Louisville, Kentucky, where, if unhindered, it spouts up 170 feet. One such well at Lillers in France has been flowing steadily for nearly 800 years. Artesian water from great depths is always warm. A well 2050 feet deep at Charleston, South Carolina, for example, has a temperature of 87° F.

Artesian wells are especially important in dry regions like the Sahara Desert, where they support many oases. The French have there tapped deep sources of water derived from rain that falls many hundred miles away. Driven wells, which penetrate deep into the ground but do not strike water that rises, are also highly important in dry regions, since they give a water supply which does not dry up. They are very expensive to operate, however, since it costs a good deal to pump water from such great depths by means of gasoline or electricity. In the southwestern United States such wells are common, but they are much more feasible on cattle ranches, where only a small supply of water is needed, than on irrigated farms where a large supply is required. Moreover, the water from such wells is apt to contain a large percentage of dissolved minerals, and thus is good neither for men nor for plants.

**City Water Systems.**—The most complicated methods of obtaining and distributing water are employed in great cities. No matter what may be the source of the water, a city must have an extensive system of large water pipes or mains, and of minor pipes running to every street and house. Filtration plants are also needed in many cases, and a well-developed sewage system is always planned in connection with the water system in every up-to-date city. Each city ought also to have a reservoir sufficiently large and located high enough so that in case of sudden demands such as fires, or in case the mains are broken, there will be enough water for an emergency.

The sources of city water are very various. Some cities like Pittsburgh pump water out of rivers and have to spend much money in purifying the water and in raising it high enough to supply the hilly parts of town. Others, like Chicago, get water from lakes close at hand, and have the same problem of purification and pumping, although the cost of pumping is slight because the city lies so close to lake level. In other cases like New York, the city spends an enormous sum in building great reservoirs far away among the hills. The Ashokan Reservoir lies among the Catskill Mountains 85 miles from New York, and its water is brought to the city by a great aqueduct which goes under the Hudson River in a tunnel of great depth. Although the first cost of such a reservoir and aqueduct is enormous, the later cost is slight. Little expense is needed for maintenance, purification is unnecessary, since the reservoir is protected from contamination, and the water flows by gravity without being pumped. Some of New York's sky-scrapers, however, are so high that for a long time they had to maintain their own pumping plants in order to raise the water to the upper stories. Los Angeles, being located in a region where there is a long dry season, has to bring its water much farther than New York. It taps the Owens River on the east side of the Sierras, and brings the water through an aqueduct about 250 miles long, crossing some of the mountains in a tunnel.

Cities also get water from artesian and driven wells. Although London's supply comes chiefly from the rivers Thames and Lea, it likewise has a huge system of artesian wells driven into the underlying chalk. So numerous are these wells and so great the demand of London for water that the water table has been permanently lowered over a large area. Before Brooklyn shared New York's water supply it had a similar experience on a smaller scale.

Perhaps the most unusual method of getting a water supply is that of Baku and Aden. Both cities are located in regions so dry that sufficient fresh water cannot be secured. Hence the only recourse is to piece out the meager supply with distilled sea water. This is inexpensive at Baku because of the abundance of oil, but at Aden, where coal must be brought from a distance, the water supply is unusually costly.

**Water as a Source of Power.**—Water furnishes the cheapest kind of power. In order easily to use this power the water must flow regularly at all seasons and must descend rapidly to provide a good "head." Hence three conditions are favorable to the development of water power: (1) rugged relief, (2) lakes or other reservoirs, and (3) an abundant rainfall well distributed throughout the year.

(1) *How Rugged Relief Favors the Use of Water Power.*—In a rugged country the streams descend rapidly, and thus furnish a proper head of water. How important this is may be illustrated by comparing the Mississippi River in its upper and lower portions. The available power from the main stream of the river during its course of nearly a thousand miles in the great central plain, where it descends only five inches per mile, is only 147,000 horse-power. A smaller amount of water flowing a similar distance in the upper tributaries in regions of rugged relief where it descends rapidly, is capable of furnishing 6,430,000 horse-power, or about forty-three times as much as in the plain.

(2) *How Lakes Favor the Use of Water Power.*—Lakes are also a great help in the development of water power. They serve as reservoirs so that the volume of the rivers which flow from them varies relatively little from season to season. For example, the Niagara River, coming from the huge reservoirs of the Great Lakes, carries only one-third more water at its highest than at its lowest level. The Potomac, with no lakes whatever, is sometimes 250 times as large in flood as at low water. In July, 1911, a drought caused the lakeless Catawba River in the Carolinas to become so low that 152 cotton mills shut down for lack of power, and 70,000 operatives were thrown out of work. Such variations do so much harm that power companies have spent millions of dollars in creating artificial lakes by means of dams. This has been done on many small rivers, the Connecticut and its tributaries being notable examples.

The presence of abundant vegetation has somewhat the same effect as lakes in steadying the volume of rivers. Where the slopes are well covered with vegetation, the rain does not run off all at once, but is caught in the rootlets and soil and seeps out slowly in springs. This is one of the chief arguments for forest conservation.

(3) *How Abundant Rainfall Favors the Use of Water Power.*—The value of abundant and regular rainfall in promoting the use of water power may be judged from a comparison of Wisconsin and Nevada. Although Wisconsin is only half as large as Nevada and is much less rugged, its water power possibilities are several hundred times as great because of its heavier rainfall. In the northern Pacific drainage area of Washington, Oregon, and Idaho the abundant rains combine with favorable relief to cause that region to be capable of furnishing two-fifths of the water power of the United States. Although the water power in that region is not yet greatly developed,

FIG. 42.—Dam and Water-Power Site at Manchester, N. H.

A New England factory town at a rapid due to glaciation.

FIG. 43.—Reed Boats on the Indus River.
A sample of primitive transportation by water.

it may some day furnish nearly 15,000,000 horse power, that is, more than is obtained from the 150,000,000 tons of coal burned each year by the railroads. This, however, would require a dam every few miles, that is, at every place where a head of water could be secured. The presence of cheap power is sure some day to cause that region to become prominent in manufacturing.

**How Seasonal Variations Hinder the Use of Water Power.**—The chief disadvantage of the northwestern water power is that, although the rains fall heavily part of the year, they diminish greatly in summer. In the United States the irregularity of the rains reaches a maximum in the Southwest. The winter rains on many of the mountain ranges of Utah, Arizona, and southern California would furnish abundant water power, but it does not pay to build power plants because they would have to be idle during the long dry summer. Moreover, they might be ruined by the floods which are characteristic of such regions, where the bare slopes of the mountains have little vegetation to hold back the water in winter. Some of these mountains, however, are so high that much of their precipitation takes the form of snow. If this melts slowly it acts like a reservoir, and holds back the water until the warm dry season when it is needed. Sometimes it melts rapidly and forms bad floods. Some of the worst floods in regions like New York and Pennyslvania are due to the melting of the snow which represents the accumulated rainfall of the winter.

**Why Glaciated Regions have Abundant Water Power.**—(1) *Falls and Rapids.*—The parts of the world which possess the most favorable combination of rugged relief, many lakes, and abundant rainfall have all been glaciated. This is because during the cold, stormy glacial period in the earth's history, great glaciers spread out from cool, well-watered elevated regions. As they moved slowly forward they changed the topography, turning rivers out of their courses so that they formed numerous falls and rapids, and causing many great hollows which are now filled by numerous lakes. Niagara Falls, the finest source of water power in the world, came into existence because ice closed the ancient outlet of Lake Erie. The lake overflowed along a new course, which caused it to tumble over a cliff. Hence to-day Niagara Falls furnish light and power to multitudes of people. They might furnish three million horse-power, or nearly a tenth of all that is used in the United States, if the governments of the United States and Canada had not imposed restrictions in order to preserve the wonderful natural beauty of the tremendous waterfall.

In New England, Wisconsin, and similar regions the ancient glaciers did not cause such striking falls as at Niagara, but gave rise to many smaller ones, and to frequent rapids which can easily be dammed. This has stimulated the growth of such industrial cities as Manchester, Nashua, Lowell, and Lawrence on the Merrimac River, Holyoke, Springfield, and Hartford on the Connecticut, and a string of small cities on the lower Fox River in Wisconsin (see Fig. 42.)

In mountainous regions the ancient glaciers deepened the valleys and steepened their walls so that tributary streams often enter the main valley in a series of cascades which can readily be utilized for power. In Switzerland and Norway, where glaciers persisted in valleys for thousands of years after the continental glacier had retreated, such falls are numerous, and are one reason for the preeminence of those countries in the use of water power.

(2) *Glacial Lakes.*—Over 90 per cent of all the lakes in the world are due to glaciation. In some cases, such as the Great Lakes, the Finger Lakes of Central New York, and the famous lakes at the foot of the Alps in northern Italy, the glaciers dug out enormous hollows which were filled by water when the ice melted. In other cases, such as hundreds of lakes in New England, Wisconsin, Canada, and Russia, the ice laid down great masses of rock and soil called moraines, and these caused lakes by acting as dams. Wherever such lake regions have sufficient relief they afford all the conditions needed for the development of abundant water power. The glacial lakes, falls, and rapids of New England, for example, are one of the chief reasons why New England early developed its manufacturing industries and is still able to maintain its position although it has neither coal nor raw materials.

**The Value of Water Power in Switzerland.**—In the use of water power Switzerland is even farther advanced than New England. To-day the power used by practically all the street railways and by the bulk of the industrial enterprises in that country comes from waterfalls. The railways, too, are giving up coal and using hydroelectric power, that is, power derived from electricity generated by the streams that pour down from the mountains. The loom of the lace-maker and the machine of the watchmaker in the home are also being driven by hydro-electric energy. Such energy even goes into the barn and house of the peasant. Thus grain is threshed, butter is churned, water is pumped, food for cattle is prepared, and the farmer is relieved of his most arduous labor. Much of this development of water power is due to the wise policy of government regulation and the payment of royalties to the state by users of the water.

**The Growth of the Use of Water Power.**—In view of the great demand for power it seems strange that only about one-sixth of the possible water-power of this country has been developed. We must remember, however, that many of the best water-power sites have been unavailable because located in mountainous regions where the rough ground affords little opportunity for factories and houses, and where transportation is expensive. At last, however, hydro-electric methods of transmitting power have so developed that not only is a 400-mile line in operation in southern California, but engineers are considering the construction of a 700-mile line in Africa from the Victoria Falls of the Zambesi to the mines at Johannesburg.

No water power site can hope to rival Niagara. The size of the river, the sudden fall from a great height, the regularity of the rainfall, and the steadiness of the river because of the great reservoirs back of it are all advantages of the highest order. In addition to this the falls are located in a comparatively level region where transportation is easy and cheap, and where there is plenty of room to establish factories and build houses. And finally, the falls are in a district where the population is dense, energetic, and progressive, and which even without water power would be one of the world's great manufacturing regions.

The nearest rivals of Niagara are both called the Victoria Falls. One, on the Zambesi, is over twice as high as Niagara and carries an enormous volume of water. The other, on the River Iquassu on the boundary between Brazil and Argentina, and only 16 miles from Paraguay, is 215 feet high and has a series of twenty falls separated by islands just as Goat Island separates the American and Canadian Falls at Niagara. Neither of the two Victoria Falls has yet been used for water power because both are located in an unfavorable climate far from manufacturing centers.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Discuss the relation of the following places to inland waterways: Pittsburg, Manchester (N. H.), Mainz, Belgrade, Assouan, Port Said, Minneapolis, Ashokan. What bodies of water have helped to make these places important? To what uses is the water put in each case?

2. Measure the approximate length of the longest river in each of the following regions: the United States, Russia, England, France, Germany, and New York State. Draw a graph representing the relative lengths of these rivers. Also show graphically the total population of all the cities of over 100,000 along each river, using the table of cities in the *World Almanac*, or an elementary geography.

3. On an outline map of the Atlantic States locate the following places: Manchester, N. H., Lawrence, Fall River, Springfield, Waterbury, Trenton, Richmond, Raleigh, Columbia, Augusta, and draw the rivers on which they are located.

Find out what common characteristics these places have, (*a*) in chief occupations; (*b*) in the use of inland waters; which ones appear in Fig. 44? Interpret Fig. 44, by showing how far the location of cotton factories depends on inland waters and how far on other geographical conditions.

Insert on your map the cities at the mouths of the rivers already located. Find out how far these cities and the factory cities are benefited by the use of inland waters for navigation. Give reasons why New England rivers are more or

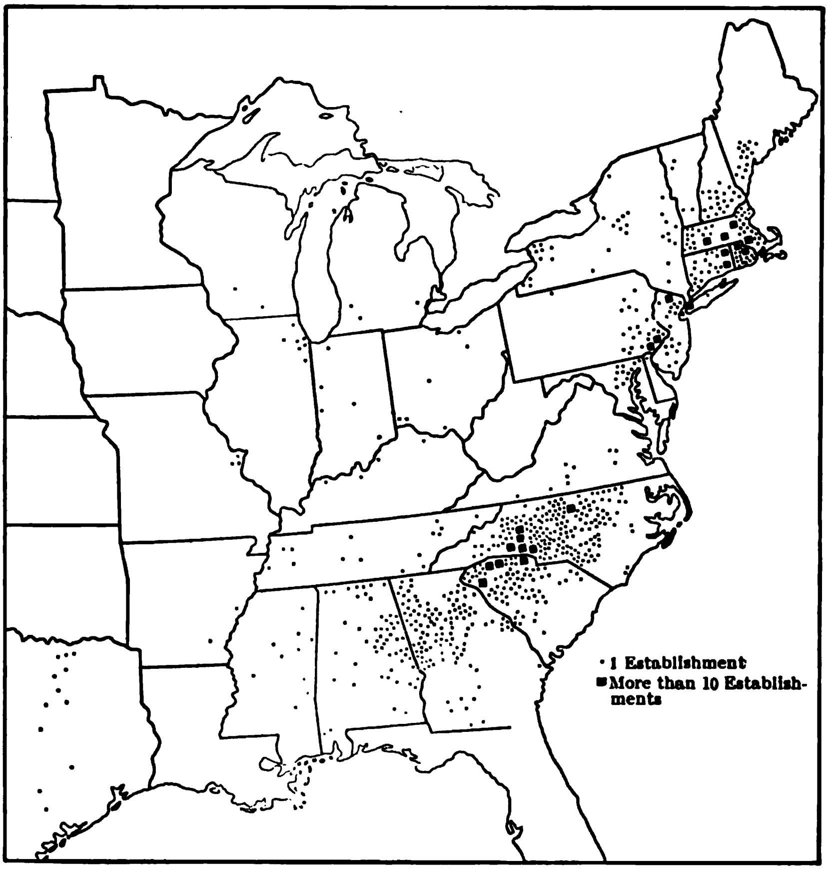



Fig. 44.—Cotton Mills in the United States.

less useful for either power or navigation than are the rivers of the Carolinas and Georgia.

4. Try to find out from a relief map and a rainfall map what are the prospects of getting enough water power to run factories in New Zealand. Find out other conditions which may cause industry to develop.

5. "North Italy has undergone an industrial revolution during the last century." Find out to what extent this development is due to the physical geography of the region.

6. Look up the U. S. G. S. map of Mount Shasta and explain why the southern edge of the mountain is so much more cut up than its northeastern part.

7. Use the following maps: (*A*) relief map of the world; (*B*) rainfall map (Fig. 81); (*C*) distribution of population (Fig. 37). From a comparison of these three make lists of the four regions where you think that there are the greatest possibilities of investment in each of the following kinds of enterprises: (*a*) the development of water power for manufacturing; (*b*) the construction or improvement of inland waterways for navigation; (*c*) the utilization of existing inland waterways for commerce. Justify your choice of regions.

# PART V

## *MAN'S RELATION TO SOIL AND MINERALS*

## CHAPTER VII

## SOIL AND THE FARMER

**The Relation between Soil and Plant Food.**—The poets sometimes speak of the earth as the mother of all things. They mean that practically all living things depend upon the soil for existence, the plants directly, and animals and man indirectly. To suppose, however, that the soil supplies the main food of plants is a mistake. From 93 to 95 per cent of the dry weight of plants consists of carbon, oxygen, and hydrogen derived from water or from the carbon dioxide of the air. The water comes to the plants through the soil, but its amount depends primarily upon climate and relief. The relative abundance of water has more effect upon the distribution and character of life than has any other factor except temperature. The carbon dioxide of the air, on the contrary, although as essential as water, has little effect upon the distribution of life or upon variations in character from place to place, because the supply of air is sufficient practically everywhere, and the percentage of carbon dioxide varies very little except in a few extreme cases. If water is abundant, plants can get carbon from the air anywhere, and some species can grow in almost any soil.

The nitrogen which forms an appreciable percentage of all plants also comes originally from the air. Only certain nitrogen-fixing bacteria, however, are positively known to take nitrogen directly from that source. They thrive on the roots of leguminous plants such as clover. All other plants obtain nitrogen from the soil, but even this comes chiefly from decayed organic matter. In addition to this the soil supplies from 1 to 4 per cent of the weight of the average plant in the form of mineral matter or ash. This small percentage is absolutely essential. In a certain way it bears to the main elements a relation analogous to that of salts, acids, and vitamines to the carbohydrates, fats, and proteids which form most of the food of man. It should be noted that the various chemical elements derived from soil, air, and water are not exactly plant foods when first absorbed by the plants. Before they can nourish the plant they must pass through the chlorophyl cells and be changed into starch, sugar, proteids, fats, and other substances like those which nourish animals.

The soil also serves as a base or foundation upon which the plants can grow and in which they can spread their roots. Thus the functions of the soil may be summed up as follows: (1) to act as a physical support of vegetation, (2) to serve as a medium for storing water and bringing it in contact with the roots, and (3) to supply a small but essential percentage of the materials which are converted into plant food by means of light. This last fact makes the soil a great problem and involves an expense of millions of dollars each year. Although water and carbon dioxide supply most of the bulk of plants there is no danger of exhausting the supply. The necessary chemicals of the soil, on the other hand, can be rapidly exhausted. Each year we put back only part of the fertilizing elements that we take away, so that year by year the soil becomes less fertile and the earth poorer. Some day we shall realize that among the things that man wastes or destroys none is more important than the common soil beneath our feet.

**How Soil is Formed.**—(*a*) *Mechanical Agents.*—All soil is derived from rocks. The first process is the breaking of the rock into fragments by mechanical agencies. (1) When rocks are heated by the sun and cooled by the wind and rain, they alternately expand and contract. This causes them to crack like a piece of glass in hot water, although not so violently. The Sphinx in Egypt has been chipped in this way. (2) The rocks are also broken into fragments by movements due to the earth's contraction. The largest of these movements are earthquakes. Still other cracks are formed because the rocks have contracted while cooling and hence have split a little and then settled downward. Even where the rocks appear solid their upper parts are broken by innumerable cracks. Into cracks formed in any of these ways rain water percolates sooner or later. If it freezes, it expands and thus pushes open the cracks a tiny bit and forms new ones. When it melts, the water settles into the enlarged openings. Then if it freezes again, they are enlarged still more. (5) Where small particles of rock lie on the surface running water, waves, and winds all move them and thus grind them still finer. At the same time the removal of the soil by these agencies exposes new rock. In places like Cape Cod, the wind sometimes carries the loose sand along with such violence that windows are etched so that people cannot see through them.

(*b*) *Chemical Agents.*—The cracks formed by mechanical agents make it easy for chemical agencies to convert the rock into soil. (1) The water that percolates into the ground is sure to contain impurities. From the air it gathers some of the carbonic acid gas given off by animals when they breathe. On the surface of the ground it seeps among decaying leaves, roots and other organic matter, and there dissolves humic acid, ammonia, and other chemicals. Thus the water becomes a weak chemical solution, usually acid, and is able to dissolve some minerals and weaken the rest.

(2) The air itself, especially when moist, produces similar results. The water, oxygen, carbonic acid gas, ammonia, and other chemicals which the air contains in minute quantities cause decay. The process is like the rusting or oxidizing of iron, which sometimes goes on so rapidly that a bright blade may become red when left out of doors overnight. Oxidation is the commonest method by which rocks are converted into soil. The red, yellow, or brown coating on the outside of rocks is the result of oxidation.

(*c*) *Organic Agents.*—Anything which helps to expose bits of rock to the attack of air or water helps to make soil. (1) A lichen helps when it attaches itself to the side of a bare, solid rock. (2) The higher plants help when they send rootlets into cracks. As the roots grow the cracks are forced open. (2) Animals such as woodchucks and prairie dogs expose bits of rocks to the air when they dig their burrows. (3) The patient ants in the same way bring up innumerable tiny bits of rock and place them within reach of sun and rain. (4) Angle worms get their food by eating the fine soil. In the process of digestion they take out the decaying organic matter, while the soil passes through them and is subjected to chemical action.

If all of the soil of a given region were swept into the ocean the mechanical, chemical, and organic processes here described would in time break up the exposed rocks and form a new cover of soil, but it would take hundreds of thousands of years.

**Kinds of Soil.**—(1) *Gravelly Soils.*—For most kinds of plants the gravelly soils formed by swiftly running water are generally too coarse. They allow air and water to penetrate freely to the roots, but do not retain the water, and the crops are apt to dry up. Moreover, although the roots can find their way easily among the particles, the soil does not furnish soluble chemicals in sufficient quantities. Gravelly soil is also hard to plow and cultivate because of the stones. When a flood in the Miami River spread four or five inches of gravel over some of the farms in Ohio the farmers were completely discouraged at first. Then they went to work with tip carts and laboriously cleared off the gravel acre by acre.

(2) *Sandy Soils.*—Sand, which usually consists largely of quartz grains, has similar disadvantages. It is, indeed, easy to plow and cultivate, but it furnishes little nourishing material for plants, and the water runs through it quickly. In the sandy "pine barrens" of Carolina, Georgia, and Florida the water escapes so fast that only a few grasses can grow, and the country is almost a desert. In Florida the orange grower must each year give his groves tons and tons of fertilizer, because the sand in which the orange trees grow contains such small supplies of the essential chemicals.

(3) *Clayey Soils.*—Clay has the opposite faults from sand and gravel. Although it contains a fair supply of the essential chemicals in relatively available form it is so sticky and compact that plowing is difficult. Even the strongest plants can barely send their roots into it, and the well-digger dreads "hard pan," as he calls a layer of clay, almost as much as solid rock. In Chinese Turkestan certain streams that are used for irrigation bring down large quantities of clay and spread it on the fields to a depth of two or three inches in a single season. When the clay dries it forms a solid cake so hard that it must be left two or three years before it can be cultivated.

(4) *Loamy Soils.*—Many soils consist of *loam*, a mixture of sand and clay. The best loam also contains *humus*, or decayed vegetable matter. Peat and coal were originally pure humus. Since humus consists largely of carbon it gives a dark or even black color to the soil. Although humus is of great value as a fertilizer, plants do not flourish in it alone. Thus neither pure sand, pure clay, nor pure humus is good for agriculture. What the farmer most desires is a rich loamy mixture of the three which has the good qualities of each.

**Poor Soil and Poverty Compared with Rich Soil and Prosperity.**—Most parts of Georgia and Alabama consist of a coastal plain which has been worn down somewhat, so that it now forms belts of varying soil and topography. The outermost belt, bordering the coastal swamps, has a poor sandy soil. Hence much of it is still uncultivated and is covered with pine forests, so that it is known as the "timber belt." Except where large quantities of fertilizer are used the farmers of the timber belt are poor and backward. The soil yields such scanty returns that the population is sparse; schools and churches are rare; and the teachers and ministers very poorly paid; trails often take the place of roads; and few of the roads are improved; physicians are so few and far between that sick people often die before one can be secured; and most of the people know little and care less about what is going on elsewhere.

Inland from the timber belt lies the "black belt," so called because of the rich, deep, black loam. Everywhere the fertile soil is so well adapted to cotton raising, that this region is also known as the "cotton belt." The land owners are very prosperous and the population dense. Formerly, the rich soil made slave labor especially profitable, and the number of colored people even now is so large that people sometimes mistakenly suppose that their presence is the reason for the name "black belt." Some of the most prosperous cities, such as Selma and Montgomery, are located in this region, and the general conditions of education and culture are unusually high. From some of the counties blessed with this fertile soil the proportion of young people who go to college is remarkable, and naturally many of them become the leading men of the State. Thus while sandy soil leads to poverty and ignorance, a rich soil opens the way to comfort and opportunity.

**Why Transported Soils are Generally more Fertile than Residual Soils.**—The character of a soil depends partly on the kind of rock from which its various parts were originally derived. Soils that have not been moved from their place of origin are called *residual*, because they *reside*, as it were, where they were first formed. Residual soils derived from quartz-bearing rocks like granite are apt to be so sandy and poor that the farmers can scarcely make a living. The residual soil derived from dark heavy lavas or from limestone, on the other hand, is generally rich in essential chemicals, but often has the disadvantage of being clayey and sticky. In wet weather the horses can scarcely pull the plows and the plowman's boots are almost dragged from his feet. If fine sand could be brought in and mixed with such soils they would form almost ideal loams, soft, pliable, and easily worked.

Fortunately a large portion of the earth's soil does not remain where it was formed. It is carried by running water, glaciers, or wind and mingled with other soils. Thus sand and clay are brought together and form loams. A soil that is poor in one essential ingredient is mixed with a soil that is rich in that respect. Hence transported soils are on the whole much better than residual soils. They are found as a rule in plains and lowlands while residual soils prevail in highlands. That is one reason why plains are much more prosperous than mountains.

**How Transportation by Glaciers Improves the Soil.**—As an example of the way in which transported soils are better than residual soils let us take the glaciated part of Wisconsin. Two of the most characteristic actions of glaciers are, first, that they scour off the more rugged prominences, and second, that they carry along large quantities of the material thus scoured from distant regions. This "drift" material, as it is called, consists of fine soil mingled with boulders. It is deposited in the low places and tends to fill up the hollows. The transported soil thus formed is improved by the mixture of materials from one region with that from another. This is especially the case where drift from a limestone area is brought into a region of sandstone. The following table shows how great is the difference between the average crops from the glaciated part of Wisconsin and from the "driftless" area of that State where the glaciers did not come:

AVERAGE NUMBER OF BUSHELS PER ACRE

| | Corn. | Rye. | Potatoes. | Average. |
|---|---|---|---|---|
| Driftless Counties | 21.0 | 9.6 | 76.0 | 35.5 |
| Glaciated Counties | 25.3 | 11.3 | 107.0 | 47.8 |

In every case the glaciated soil yields a larger return. The reason is that the sandy residual soil of the driftless areas is poor. Where the glaciers have brought large quantities of drift from limestone areas to sandstone areas, it is as if the farmers had brought large quantities of lime for fertilizer. The presence of such fertilizers is worth millions of dollars to a great many glaciated regions. It is estimated that the value of glaciation to the State of Wisconsin amounts to at least $50,000,000 per year. Most of this is due to the improvement of the soil by transportation. Because of this extra income of the farmers, Wisconsin is able to have better roads, better schools, and a better university than would be possible otherwise.

**How Climate Influences the Soil.**—Other conditions affect the soil quite as much as does glaciation. Before the soil can be used by plants its valuable portions for plant food must be dissolved. In tropical countries, where rain is abundant and the chemical processes active because of the heat, the more soluble elements are sometimes wholly dissolved and carried away, thus practically ruining the soil. In dry regions, on the contrary, the rainfall is so scanty that the plant foods are neither carried away, nor used by vegetation. In fact, materials from lower layers of the soil are often brought to the surface so that the soil grows richer and richer. This is because much of the rainfall of dry regions sinks into the ground only to come out again by evaporation. As it evaporates it leaves the dissolved chemicals behind. If the farmer irrigates such soils he finds them unusually fertile. This partly accounts for some of the wonderful crops in New Mexico, Arizona, southern California, eastern Washington, and Oregon.

In ordinary temperate climates with a fair amount of rain the plant foods are not washed away as they are in the wet, warm tropical regions, nor do they accumulate as in dry regions. Hence ordinary vegetation usually has enough of each kind, but when a single crop is cultivated for a number of years certain chemicals are used up more rapidly than they are prepared by the processes of weathering. There may be enough of them, but they are not ready for use.

**The Unwise Use of Soil.**—Since all life depends on the soil it is evidently of supreme importance to preserve or renew its fertility. In a state of nature most plants die where they grow. The materials which they contain are thus returned to the soil through decay. Moreover, there are usually many varieties of plants on the same area, so that the same kind of food is not demanded by all. On farms, on the contrary, it is usually necessary to devote the whole of a given area to a single crop at any given time. When the crop is reaped, it is carried away and consumed somewhere else. Thus there is a great drain on the soil. For example, many early settlers of the great plains of our Central and Western States wanted to get rich as quickly as possible. Accordingly, they planted wheat or some other favorite and profitable crop year after year, and returned nothing to the soil. At first the crops were wonderfully abundant, but soon the soil began to show signs of exhaustion, the crops fell off, and the value of the farms declined. They forgot that one of their duties is to see that the fields are passed on to their descendants in good condition. In the Southern States, also many farmers have injured their lands by planting nothing but tobacco, which speedily exhausts the phosphorus of the soil, or cotton, which does the same thing more slowly. These crops bring good prices and are an easy way of getting ready money, but to sell the fertility of the soil along with the crop is like killing the goose that lays the golden eggs.

**The Wise Use of the Soil.**—(1) *Rotation of Crops.*—The wise farmer lessens this drain on the soil in two ways: (1) by rotation of crops, and (2) by using fertilizers. Rotation of crops means that the farmer plants different crops from year to year, so that on a given area the same elements are not constantly required in large amounts. It is called rotation because after a few years the same series of crops is planted over again. In planning a rotation the object is not only to use crops which do not require the same food, but to include some, such as buckwheat and clover, which can be plowed under to serve as fertilizer. For instance, beets need a great deal of potash, while wheat in proportion to its bulk requires only half as much, but needs nearly twice as much nitrogen. Clover, and peas, on the other hand, do not require much nitrogen from the soil. Indeed they actually take nitrogen from the air and give to the soil. Hence beets, wheat, and peas would make a proper rotation.

The rotation of crops has still another value, as the people who raise cotton found out in the early part of the Great War. As England prevented the shipment of cotton to Germany and Austria, the market for the crop was restricted and the price fell very low. As the farmers had no other important crop to sell many of them could not pay their debts, even though they had large supplies of cotton. If they had practiced rotation of crops, part of their land would have been in corn, part in beans, peanuts, or sweet potatoes. They could have sold these crops at good prices and thus have been able to get along for a year or more until cotton again rose to a profitable price. In 1915 they began to learn this lesson, and planted far more corn than ever before. The rotation of crops also helps in checking the ravages of insects and of various plant diseases due to bacteria and other causes. Wise farmers find that a variety of crops is as valuable in peace as in war.

(2) *Use of Fertilizers.*—The Southern farmer who raises cattle and pigs can use the second method of preserving the fertility of the soil. The seed from his cotton, after the oil has been extracted, makes good food for cattle, while corn is the best kind of food for pigs and hens. Thus much of the nutriment taken from the soil by the crops is returned in the form of manure. The Chinese not only return to the soil all the waste products of animals, but also human waste and sewage which we permit to pollute our rivers and harbors. Inevitably, however, if some products are carried away from the farm, there is a loss of fertility, even though there is a wise rotation of crops and many animals are raised. If weathering is very rapid this loss may be supplied by the freeing of new materials in the lower parts of the soil, but generally the soil becomes steadily poorer unless artificial fertilizers are employed.

**What Chemicals Plants Need from the Soil.**—In order to provide the right kind of artificial fertilizers it is necessary to know (1) what chemical compounds plants need, and (2) how much of these the soil contains. A good soil must contain at least seven chemical elements in such form that they can readily be dissolved and absorbed by the plants. Three of these are magnesium, iron, and sulphur. The farmer need not worry about these, for they are practically always present in sufficient abundance for any kind of crop. The supply of the other four—calcium, phosphorus, potassium, and nitrogen—is often inadequate. Certain other elements such as silicon, chlorine, and sodium are also taken from the soil by plants, but do not seem to be essential, for growth goes on apparently unchecked without them. Therefore, among the many chemicals of the soil, only calcium, phosphorus, potassium, and nitrogen cause the farmer trouble because they are not available in sufficient quantities.

**How the Farmer Knows what Kind of Fertilizer to Use.**—The following table shows the amount of the chief elements used by an acre of beets each year, the amount of each in the upper part of an ordinary loamy soil, and the number of years that the element would last if the beets could get every bit of it. Evidently the farmer who is raising beets needs to provide fertilizers rich in potash and nitrogen rather than in phosphorus and calcium. It must be remembered, however, that the process by which nature prepares the soil ingre-

*By courtesy of U. S. Dept. Agriculture.*

FIG. 45.—A Phenomenal Corn Crop Raised by Boys.

This shows what can be done even by boys if the soil is properly enriched and cultivated.

dients is slow. Hence if beets are raised each year they exhaust the available supply while large reserves are still waiting to be prepared. Even after five or ten years, unless fertilizers are applied, the available nitrogen would be so scanty that the crop would not be worth raising. In other kinds of soil, some of the other chief elements may be exhausted. For example, in a sandy soil, the plants are stunted for lack of lime.

FIG. 46.—Wheat Threshing in Oklahoma.

A combination of old and new methods ranging from the ox cart and the horse-drawn "grub wagon" to the steam tractor engine, but not including the gasoline engine which is now common.

RELATIVE AMOUNTS OF IMPORTANT INGREDIENTS IN AN ORDINARY SOIL

| A<br>Soil Ingredients | B<br>Amount used Each Year by an Acre of Beets, Lbs. | C<br>Amount in Upper Foot of an Acre of Loam, Lbs. | D<br>Number of Years that Ingredient Would Last if Whole Supply were Available. |
|---|---|---|---|
| Calcium in the form of lime | 43 | 54,000 | 1,260 |
| Phosphorus in the form of phosphoric acid | 53 | 12,800 | 240 |
| Potassium in the form of potash | 300 | 23,000 | 77 |
| Nitrogen in the form of nitrates and ammonia | 149 | 7,000 | 47 |

**Artificial Fertilizers.**—*Lime.*—In searching for fertilizers other than manure, it is necessary to find materials which are not unduly expensive and which will furnish lime, phosphoric acid, potash, and nitrogen in forms that the plants can readily assimilate. Lime presents no special difficulty. Almost all parts of the world contain limestone beds, and it is merely a question of finding the cheapest means of pulverizing the rock and making it easily accessible to the plants.

*Phosphates.*—Phosphates are not so easy to find. They are obtained from four chief sources: (1) They occur abundantly in a few minerals such as *apatite*, but these are generally so intermingled with quartz, feldspar, and other materials that it is difficult to prepare the phosphates as a fertilizer. (2) The easiest source is the slaughter house, from which the bones and refuse meat of domestic animals are taken to ill-smelling fertilizer plants. In former years bone-hunters drove their wagons over our Western plains gathering the skeletons of buffalo and cattle that had perished in blizzards, by the wolf pack, or at the hand of the hunter.

(3) As the present supply of bones and other animal refuse is not sufficient, man draws on the past. One of the important sources of phosphates is great beds of *guano* or bird droppings on several dry islands of the South Pacific and West Indies. From about 1830 to 1880 guano worth about $600,000,000 was taken from the Chincha Islands off the coast of Peru and carried around Cape Horn to be sold in Europe and America at $30 to $60 per ton. The Peruvian government was largely supported by the taxes on the guano until the deposits were exhausted. Only a limited supply is now available. (4) To-day the world is drawing on still older deposits of animal bones and refuse in the form of phosphate rocks. The chief supply comes

from Florida, South Carolina, and Tennessee, together with Tunis, Algeria, and some of the small islands of the sea, but much is available in Montana, Idaho, Utah, and Wyoming.

*Potash.*—For a long time the United States had more difficulty in getting potash than phosphorus. The only largely worked deposits were in Stassfurt, Prussia; other sources, such as Alsace and Spain, supplied relatively little. The danger that the supply would be cut off, and the price rise to a prohibitive figure led the United States government to undertake a search for new sources. This led to the use of several salt lakes whence most of the limited American production now comes. It also led to the use of kelp along the Pacific coast, as already described, and to the further development of the processes of extraction of potash from the dust of cement mills and blast furnaces.

The largest single source of potash in the United States is Searles Lake in southwestern California. This strange desert lake, twenty square miles in extent, resembles a mass of ice covered with an inch or two of slush and saturated with bitter brine. The ice-like material is rock-salt and other saline materials deposited as crystals by the drying up of a large lake whose traces are still seen in numerous shore-lines at high levels. The brine is pumped from wells 75 or 100 feet deep and evaporated until the potash crystallizes out. The product is shipped all over the country to replace that which the farmers have sent to market in the form of meat, wheat, and other food supplies. If the farmer would properly preserve the straw, cornstalks, cotton-seed bulbs and similar substances that are now wasted or burned, the need of potash would be much diminished.

**The Search for Nitrogen.**—Among the essential ingredients of the soil nitrogen is much the hardest to obtain. Its original source is chiefly the air. The amount in the air is inexhaustible. Yet until recently it was almost useless to the farmer, for no one knew how to convert it into a soluble compound that could be carried through the roots of the plants. This is because nitrogen is one of the most inactive chemical elements. Quite unlike such an active substance as oxygen, it will not readily unite with other elements.

No plants are by themselves able to take nitrogen from the air. Fortunately, however, there are certain bacteria which have this power. They grow only on plants of the legume family, that is, on beans, peas, clover, alfalfa, and similar species. They thrive especially on the roots, where they form little bunches or tubercles full of nitrogen. All other cultivated plants diminish the supply of nitrogen in the soil; the legumes alone replace it. Farmers have known for generations that it pays to plant peas or beans and plow them under for fertilizer, but did not know why. Scientific investigators after much study discovered the reason and found that the bacteria that cause " nitrification " can be raised artificially, and shipped anywhere. When clover seed is inoculated with them the roots become covered with unusually large tubercles which contain nitrogen, and thus the fields are fertilized.

Many farmers do not want their land to "waste a year," as they say, while a crop of clover refertilizes the soil. They prefer to raise something that pays in money and therefore are glad to buy commercial nitrogen fertilizers. This has had some interesting results. The Atacama Desert in northern Chile contains by far the largest known deposits of nitrates or compounds of nitrogen. They have been exploited to the value of $50,000,000 each year. The taxes paid by the British companies that work the nitrate fields are the chief sources of the revenue of the Chilean government. Before the value of the nitrogen was known the Atacama Desert was such a barren waste that no one thought much about it, although Chile, Peru, and Bolivia all laid claim to parts of it. When its value began to be appreciated, however, about 1879, the three countries wanted it. This led to a long war in which Chile was the victor.

Another interesting result of the demand for nitrogen fertilizers is seen in Norway. After the value of nitrates was realized people began to search for means of utilizing the unlimited supply of nitrogen in the air. Success was at last obtained by means of strong electric currents which cause the atmospheric nitrogen to unite with lime or other substances. Much power is required for the electric discharges, so that the process is commercially profitable only where power is cheap. The cheapest known source of power is waterfalls, which are especially abundant in rugged Norway. Since raw materials of most kinds are not abundant there and nitrogen is present everywhere the manufacture of nitrogenous fertilizers has become an important industry. In the United States part of the water power of Niagara is being used for the same purpose.

The work of obtaining fertilizers from old bone deposits, from desert lakes, and from the air may seem remote from the lives of people who live in cities. Yet it concerns every one of us. The farmers supply us with most of the materials for the food and clothing which play so large a part in the lives of all of us. If the farmers do not have rich soil and cannot raise their crops abundantly and cheaply, the price of food and clothing goes up, and we all suffer. Therefore, it is of the greatest importance that the farmers' need of good fertilizers should be fully net.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Classify the soils of the neighborhood where you live, according to their texture; i.e., (*a*) gravel, (*b*) sand, (*c*) clay, (*d*) loam. Also, if possible, classify them according to the fertilizing elements which they especially need. For help along this line write to the Director, U. S. Geological Survey, Washington, D. C., and find whether a soil report has been issued on your region. Assign to each main kind of soil its proper rank according to (*a*) the area which it occupies, (*b*) its utility to farmers and gardeners, and (*c*) the crops that are raised on it. Find out what manures and fertilizers are used to increase the productivity of each soil and where these fertilizers come from.

2. Take a small test tube, a large test tube, and a glass beaker. Fit the test tubes with corks through each of which run two glass tubes. Arrange the three vessels as shown in Fig. 47 and run a stream of water through them by connecting the rubber tube *O* with a faucet. Note that the current passing through the small tube *A* is very swift; note that the water moves less swiftly through tube

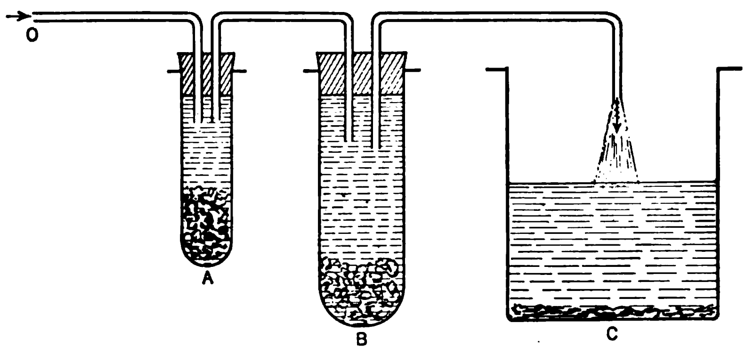



Fig. 47.—Effect of Currents on Texture of Soil.

*B* and slower still in the open vessel *C*. Now empty the apparatus and fill the tube *A* with garden soil. Run the water through it again for five minutes and examine the result. State carefully the character and size of particles found in *A*, *B*, and *C*, respectively, and interpret this rough analysis of the soil. Do the same with some sandy soil; with gravel, and with clay. Write a geographical interpretation of your results by applying them to three or four types of soil near your home.

3. Make a tracing of the map of the State of Alabama and mark the position of every town with a population of 3000 or more. A list of towns is found in the census reports and in several popular atlases. Write a careful statement of the distribution of the population indicated by your map, and suggest reasons for this distribution.

4. Find out what schemes of rotation of crops are used on the farms in your neighborhood. How and why does the rotation differ on different kinds of soil? On the basis of this and of exercise 1, make a map of the chief agricultural divisions of your neighborhood.

5. In Germany and northern France, the raising of sugar beets is nearly always connected with stock raising. Make a list, showing the advantages and disadvantages of this method.

6. At the docks at Liverpool, tramp steamers from Argentina may be seen unloading cargoes of bones. Why are the bones sent on tramp vessels; why from Argentina; and why to the United Kingdom?

## CHAPTER VIII

## METALS AND CIVILIZATION

**Why Minerals Are Most Abundant among Mountains.**—It is fortunate that the earth's intermittent contraction has bent and broken the crust and caused molten materials to move from lower to higher levels. Otherwise many minerals would be practically unknown, for metals, which are the most valuable minerals, are heavy. For instance, iron weighs three and gold seven times as much as quartz. Consequently during the earth's cooling the metals seem largely to have sunk into the interior. That is probably one reason why the earth as a whole weighs twice as much per cubic foot as does the outer mile or two of the crust. If the crust had never been bent, broken, and uplifted, and if molten parts of the interior had never been forced upward, the heavier minerals would probably now be almost entirely buried far beyond our reach.

It is equally fortunate that erosion has taken place on a large scale. Otherwise most of the metallic deposits, even though uplifted, would be buried under an enormously thick layer of dense rock. During the lapse of millions of years, however, erosion—especially the work of rivers—has carried away thousands of feet of rock and exposed many deep-seated deposits. Unfortunately, an immeasurable quantity of valuable minerals has thus been wasted by being carried to the sea as mud, but this is necessary if the underlying rocks are to be exposed.

The processes of bending, breaking, and uplifting the crust, of bringing melted materials from the interior, and of eroding the higher and more exposed rocks are all most active among mountains. There the ores and other deposits have been raised above the ordinary levels, so that they are easily exposed by erosion. Hence mining industries are largely concentrated in regions of rugged relief. Thus in the United States the chief mining regions are in the Sierra Nevadas, the Rocky Mountains, and the Appalachians. The mountainous relief of Arizona is one of the factors in its annual production of minerals worth more than $40,000,000, or a value of over $170 for each inhabitant. In the same way mountainous Montana produces over $175 per inhabitant. Texas, on the contrary, which consists largely of plains, produces minerals worth only $2.50 to $3 per inhabitant while the figure for the flat State of Mississippi is only 70 cents. None of the mineral wealth of Mississippi is metallic.

In some cases, such as the Lake Superior district, with its iron and copper, a mineral region presents almost the gentle relief of a peneplain, but the gently rounded hills still show that they were once mountains of rugged relief.

Mineral fuels, unlike most of the metals, are found in plains as well as in rugged regions. Thus coal is mined extensively in the plains of Illinois and Ohio as well as among the hills of western Pennsylvania. Among mountains, such as those of eastern Pennsylvania, the coal is likely to have been so folded, heated, and pressed that it is changed from the soft, bituminous form of the plains to the hard form known as anthracite.

Petroleum occurs almost entirely in regions where there has been little disturbance of the rocks. The world's great oil fields are often found in plains like those of California, Oklahoma, and Mexico. If the rocks are much bent, the petroleum with the accompanying natural gas is almost sure to escape.

**Stages of Mining Industries.**—(1) *Prospecting.*—The first stage of the mining industry is prospecting which includes any kind of search for valuable minerals. Among the mountains of Colorado or California, for example, one now and again meets an unkempt, unshaven prospector driving two or three donkeys laden with samples of rock to be "assayed" or tested. For months he has been camping alone and spending his days prowling among the mountains in search of rock that looks like good ore. Now and again he places a "location" paper in an empty tin can on the end of an upright stick, and leaves it to declare that he *claims* this particular *location.* If the ore proves valuable, he will file the necessary documents with the government.

The lonely and often dangerous life of the prospector makes him hardy and resourceful. He is so glad to see a new face that he is extremely open-hearted and hospitable not only to his comrades, but to strangers. In spite of these good traits, however, prospectors rarely prosper. All their dangers and hardships seldom result in riches or even in a good living. The trouble is that on their rare visits to town they promptly waste their money,—"blow it in" on gambling and dissipation,—and are soon poor again. When they make a real find their money comes so easily that they have the gambler's spirit, and spend it at once because they think that they can quickly get more. With the growth of the science of geology even the ignorant prospector is realizing the value of the trained expert who lives in the lowland cities and makes occasional expeditions to the mountains.

(2) *Development.*—After a promising prospect has been located, it is "developed," sometimes by the prospector, but usually by some lowlander who can furnish the necessary capital. "Development" consists of exposing enough ore to see whether its quality and abundance warrant the building of a mill and the installation of permanent machinery. Roads must be constructed to carry the ore to places where it can be assayed, and to bring supplies; shacks must be built; and miners must be hired. Where much development is going on small towns grow up. They are the typical smaller mining "camps" of our Western mountains. They contain almost no families, for since the work may end any day men do not bring their wives and children. The poolroom and dance hall are usually the main social centers. Wages are high; the stores charge exorbitant prices; and the miners spend their money freely. Such a camp is full of the evil influences that go with a life that depends chiefly on "luck" and not on steady work.

**Mining Booms.**—While mines are being developed among the mountains, "booms" are apt to be launched in the cities of the lowlands. The owners of a valuable prospect must replace their rough trails by good roads or railways, they must erect stamp mills to crush the ore, and smelters to melt it and separate the metal from the impurities. In order to attract capital they print glowing advertisements telling how rich and abundant is the ore and how quickly investors will grow wealthy. Often the promoters of such a prospective mine really believe what they say, but are mistaken. Equally often, unscrupulous promoters tell big stories without regard to the truth. Rarely do investors in mines that are publicly boomed recover even the money that they put in, and much less make a profit. Generally if the prospects are really good, there are plenty of people to supply the capital without much advertising. Among the urban population of this country who have a small surplus for investment many have lost money in mining ventures. They ought to know that the vast majority of mines do not pay.

(3) *Permanent Mining.*—Most mining ventures never get beyond the stages of prospecting and development. The few that survive may give rise to relatively permanent industries. Iron ore, aluminum-bearing rocks, and coal beds frequently occur in such abundance that work can be carried on in the same region for generations. The coal beds of Wales, for example, have yielded a vast supply of fuel for over a century. In the United States the enormous iron deposits of the Lake Superior district have been worked extensively since the early eighties of the nineteenth century, but they show no signs of exhaustion and some actually grow richer the more deeply

they are penetrated. The precious metals on the contrary are usually found in small veins which may suddenly come to an end without warning, and the same is true of copper and lead, but to a less degree. Petroleum deposits are also likely to diminish rapidly.

**The Precious Metals.**—(1) *Placer Mining.*—The precious metals may serve as an example of the stages of the mining industry. Gold occurs in such a form that it particularly encourages prospecting. Much of it is found in small flakes or nuggets in "placers," that is, in gravel deposited by running water. Even with the crudest apparatus the gold can be recovered. The gravel may be placed in a large pan

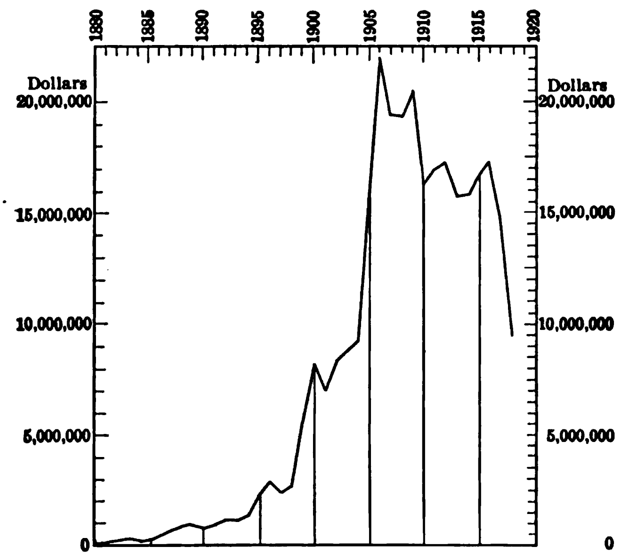



FIG. 48.—Gold production in Yukon.

with water and swirled about so that the water and gravel gradually spill out. The gold, being heavy,.stays at the bottom of the pan. Hence anyone who can pay his way to the mining region can engage in gold mining. There is always the chance of coming upon a pocket of gold dust or nuggets and becoming rich in a day.

When the news of the great gold deposits of Klondike became known in 1896, miners and adventures from many lands toiled across the bitterly cold mountains of Alaska. Everyone was so feverishly anxious to "make his pile" that almost no one was willing to do the ordinary work of life such as cooking, house-building, store-keeping, and road-building. Hence wages rose to five or ten times their usual level. Since the cost of carrying a ton a mile over the mountains was about $20, the vast majority of the 30,000 people who penetrated the region had to spend most of their earnings in paying for food and lodging. The production of gold increased rapidly for a few years as is shown in Fig. 48, but soon declined. This is typical of most mining ventures. So too is the way in which most of the miners returned home as poor as when they came.

(2) *Hydraulic Mining.*—Fig. 48 shows that after 1907 the production of gold at Klondike began again to rise. This was because of new methods. In the hydraulic method, for example, great streams of water are shot against gravel banks. The water carries the gravel into sluices where the heavy gold lodges in corrugations like those of a washboard. In California hydraulic mining has caused the bottoms of many mountain valleys to be stripped to the naked rock, for all the gravel has been washed down to the lowlands, where it does much harm to the farms. Where gold placers border navigable rivers as in the plain of California, great floating dredges scoop up the gravel and extract the gold. Such a dredge digs its own channel ahead of it, and fills the space behind itself with great heaps of washed pebbles and cobble stones.

(3) *Mines in Solid Rock.*—The particles of gold in placer deposits come from veins in the solid rock. There—far under ground—hot mineralized water long ago deposited the gold as thin plates or scattered bits in the midst of such minerals as quartz. After the excitement of a new gold field is over, prospectors begin to search for the veins that have been exposed at the surface by uplift and prolonged erosion. Then comes the more permanent stage of mining. The process of getting either gold or silver from the veins demands much capital and is impossible for the ordinary miner. Large companies are formed and towns grow up.

A good sample of such a town is Virginia City in Nevada. At first the ignorant miners there searched only for gold, and threw away a black silver ore which formed the great Comstock Lode, the richest ore deposit in the world in proportion to its size. From 1859 to 1880 the Lode produced metals valued at $305,000,000. In 1877 the value was over $36,000,000. At that time Nevada alone produced more gold and silver than all the rest of the United States. Virginia City prospered, although its food, timber, and other supplies had to be hauled up steep mountain roads to a height of 6200 feet. Although the town has lately revived somewhat because of the consolidation of properties and the discovery of more ore, Virginia City is typical of what happens when veins of precious metals become exhausted. For years the streets were almost empty, the

*By courtesy of the Carnegie Steel Co.*

FIG. 49.—A Steam-hammer Forging a Steel Axle for a Railroad Car.

**The kind of work that makes the Steel Age possible.**

Fig. 50.—Silver Mine at Broken Hill, New South Wales, Australia.

A typical mining town in a semi-arid region.

hotels boarded up, most of the houses untenanted and falling to ruin, while fine schoolhouses stood abandoned.

**Economic Importance of Gold and Silver.**—Although gold and silver are not one-thousandth as useful as iron, their attractiveness and rarity have made them the world's standard of value. In 1800 A.D. a piece of a given size would purchase almost as much wheat, barley, or milk as had been the case centuries earlier. Then the invention of the steam engine enabled civilized man to travel easily to all parts of the earth and to discover many new mineral deposits. Moreover, the use of machinery and the invention of improved processes for extracting the metals so cheapened gold and especially

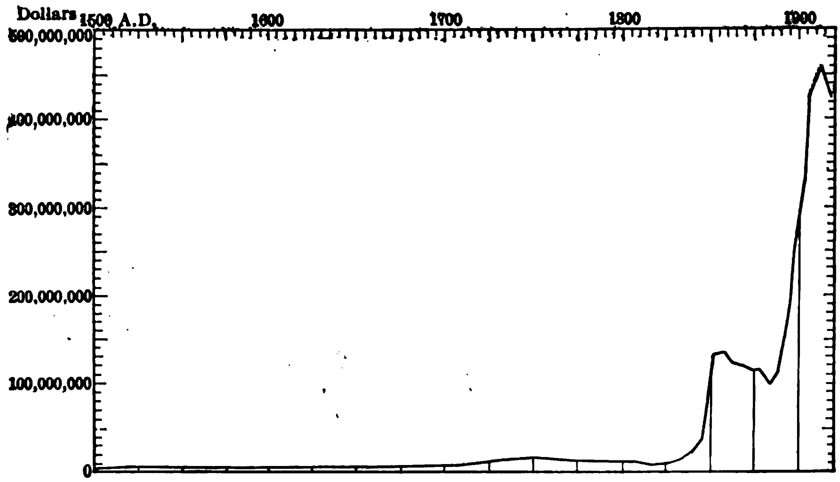



FIG. 51.—Production of Gold for Four Centuries. Annual Averages for Periods of 5 to 20 years.

silver that in the latter half of the nineteenth century most of the great countries ceased to use silver as a standard of money. In 1914 the price of silver had fallen so low that a silver dollar when melted was worth less than half a dollar. Silver coins, to be sure, were still used, but the silver in them was not worth its face value. Thus gold became the single standard of value in practically all parts of the civilized world.

**Gold Supply and the Increased Cost of Living.**—The fact that gold is the sole standard of value causes great trouble, for man is still exploring new regions and discovering new supplies. At the same time he is also inventing easier ways of recovering the metal from the rocks. Both the discoveries and the inventions tend to decrease the value of the metal. Figs. 51 and 52 show how the production of gold has varied. The ten-fold increase between 1850 and 1855 was due to the discovery of great deposits in California and Australia. After that there was almost enough gold to serve as money everywhere. Of course in most countries the gold itself does not circulate, but is kept in reserve by the government and is represented by paper money which can at any time be exchanged for gold.

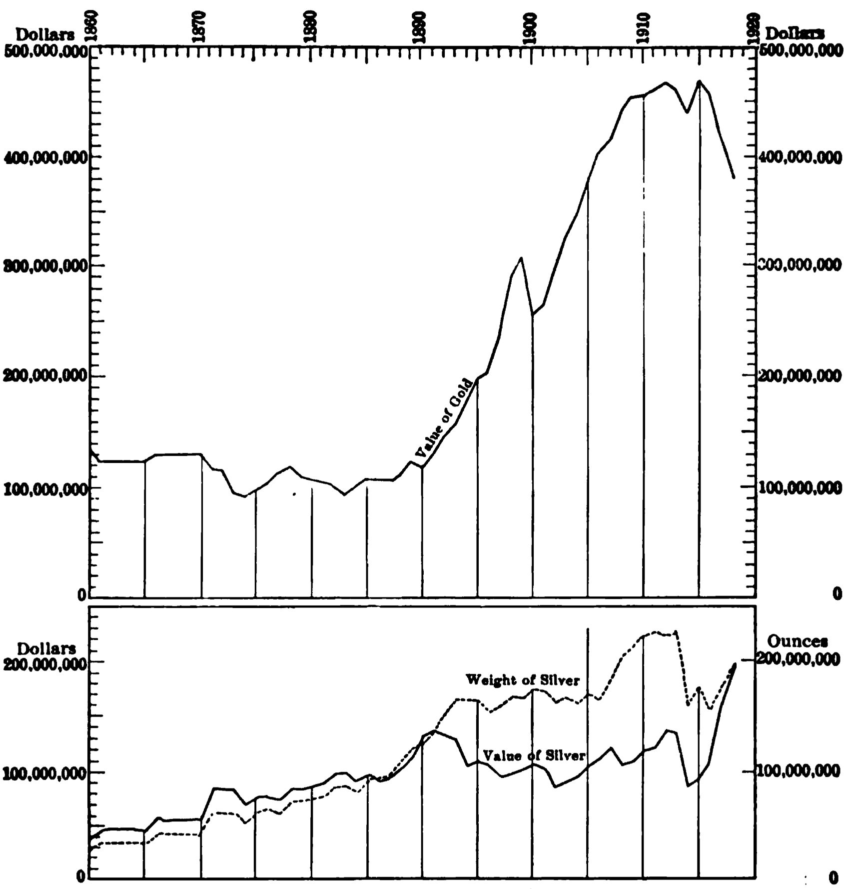



FIG. 52.—World Production of Gold and Silver Since 1860.

From 1855 to 1890 gold production changed little. Then geographical discoveries opened enormous new fields in Alaska, Australia, and especially South Africa. The supply of gold increased about five-fold in thirty years. At the same time the cyanide process made it possible to use low-grade ores that previously were considered valueless. Gold became so common that its value fell greatly. Hence a dollar that would previously purchase two bushels of wheat would purchase only one, and an income of $1000 would buy only as much as $500 a few decades earlier. Thus even before the rise in prices due to the Great War the cost of living kept going up, which means in large part that the value of gold went down.

**Why New Discoveries May be a Disadvantage.**—The same trouble will probably reappear in the future, for geographical discovery and the improvement of mining processes and transportation have by no means reached their limits.* Western China, Tibet, Afghanistan, and especially northeastern Siberia contain vast amounts of gold, which will be exploited when railroads bring those regions into close contact with the rest of the world. In South Africa the Witwaters field alone is believed to contain from ten to twenty billion dollars' worth of gold. The increased production of gold benefits a few people, but for the majority it merely helps increase the cost of living. In this it joins with short hours, poor work, heavy taxes, and the effects of war. So much trouble arises from changes in the value of gold that many economists think it should be given up as the standard of value. They advocate a new standard based on goods of all kinds and so framed that a dollar will buy just as much food, cloth, iron, coal, or other necessities in one year as in another.

**Remarkable Nature of Iron.**—If all the gold in the world should be destroyed man's activity would go on almost unchanged, but if iron should be taken away, it would be enormously more difficult than at present to maintain our material civilization.

Why is iron used so universally? Is it because iron is the most common metal? No, for the earth's crust contains about 8.2 parts of aluminum out of a hundred, and only 4.6 of iron. Moreover, such metals as calcium (3.5 parts), magnesium (2.6 parts), sodium (2.6 parts) and potassium (2.4 parts), are only a little less abundant than iron, but are not used one-thousandth as much. Is the universal use of iron due to the ease with which the metal can be separated from its ores? Partly, but copper can be separated still more easily, and zinc with almost equal ease.

The chief reason for the universal use of iron is its peculiar properties, especially (1) its capacity for assuming many different forms, (2) its strength, (3) its hardness, (4) its ductility or capacity for being drawn into wire, and (5) its magnetic properties. Because of these qualities iron is the universal material for tools and machines, and thus becomes one of the most important factors in promoting civilization.

**How Man Has Attained the Iron Age.**—Since iron is so important it is not strange that the period in which we live is known as the

* During and after the Great War the production of gold declined and prices fluctuated for other reasons. When conditions again become stable, however, the old conditions are likely to revive unless some new factor intervenes.

Iron Age. The earliest men lived in what is known as the *Stone Age.* Their only tools were made of stone or sometimes of bone. Ordinary stones of almost any kind were used for hammers or as weapons to throw when hunting game, but only flint and a volcanic glass called "obsidian" could be easily chipped to a cutting edge. But what is such an edge compared with the edge of a razor. People with such tools are greatly hampered in the advance toward civilization.

When primitive people discovered that copper could readily be hammered into tools, the *Copper Age* began. It was not greatly different from the Stone Age, however, for copper is so soft and pliable that tools made from it can never be given an edge that will last. In time it was discovered that if a little tin is melted with copper a material called bronze is produced. This is harder than copper and makes better tools. This discovery gave rise to the *Bronze Age.* The new metal helped mankind to advance, but it did not surpass copper sufficiently to cause a pronounced change in civilization.

Not till men learned to smelt iron did there come a radical change. Since then, during the two or three thousand years of the *Iron Age,* the strength and hardness of iron tools have enabled us to clear the forests, plow the sod, dig deep mines, and construct railroads, steamships, and all kinds of machinery. Within the last half century the increasing use of iron in its strongest and hardest form has brought us into the *Steel Age,* a new stage of the Iron Age. In 1870 the United States produced 1,665,000 tons of pig iron, only 4 per cent of which, or about 70,000 tons, was used for steel. In 1900 the output of steel had increased to 10,000,000 tons, in 1905 to 20,000,000, in 1913 to 32,000,000, and in 1918, at the climax of the Great War, to 50,000,000.

The utilization of the magnetic properties of iron has enabled man to enter upon a still more advanced stage of the Iron Age, the *Age of Electricity.* As lately as the early part of the last century the only practical use of the electro-magnetic power of iron was in the compass. To-day we depend upon electricity not only for lighting, transportation, and communication, but also for the transmission of power from waterfalls, for motive power in factories, and for a host of other uses. Even now the full possibilities of the magnetic properties of iron are only beginning to be realized.

**Scanty Iron Deposits and the Character of Early Civilization.**— One of the chief reasons for the differences between the ancient civilization of Egypt, Palestine, Mesopotamia, Greece, and Rome, on the one hand, and the modern civilization of Western Europe and the United States, on the other, is the amount of iron available for everyday use. In phases of civilization such as art, literature, philosophy, religion, and government, in which mineral resources play only a small part, the people of ancient times made great progress, and in many ways excelled the nations of to-day. In other phases such as manufacturing, transportation, commerce, and mining, where complex machinery plays an important part, they made little progress and were in about the same stage as nations like modern China. This difference was due largely to the degree of availability of supplies of iron (see Fig. 53).

Iron ores do not occur in plains like those of Egypt, Mesopotamia, northern India, eastern China, and Guatemala, where the world's earliest civilizations grew up. Nor are such ores abundant and easily

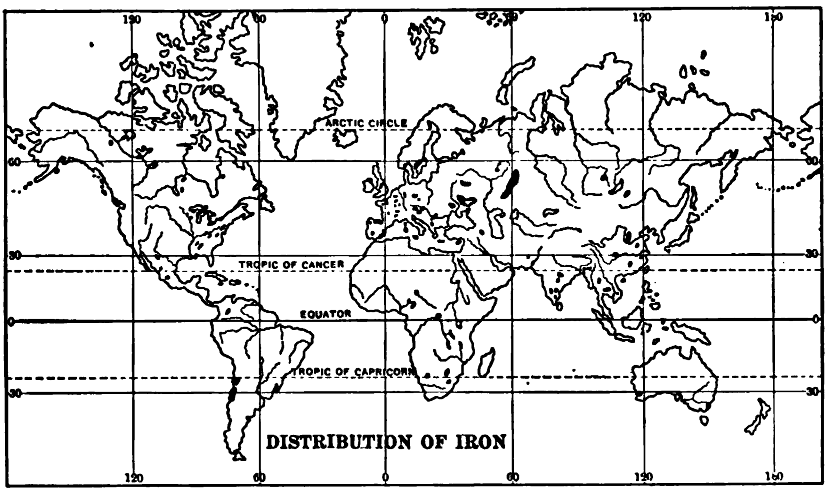



FIG. 53.—Distribution of Iron Ore.

obtained in limestone countries like Syria and Greece. Italy also has only a little iron, and most of that comes from the island of Elba. Thus practically all of the great countries of antiquity are deficient in natural supplies of iron. Moreover, in those countries and also in some outlying regions such as Asia Minor and the Libyan Desert where ore is found, there are comparatively few trees, and thus the smelting of iron was greatly limited. With their small available supply of iron the civilized people of early times made only such small tools as knives, hoes, and weapons. Simple machines such as the steam engine of Hero of Alexandria, 130 B.C., and the hand loom which was widely used, had indeed been invented, but could not be extensively developed for lack of iron.

**Abundant Iron Deposits and the Character of Modern Civilization.**—Modern civilization, unlike ancient, is located in regions where it is easy to procure both iron and the fuel to smelt it. The most energetic races dwell in countries such as northern Spain, France, Belgium, Germany, England, and Sweden, which contain abundant iron ores and are naturally covered with heavy forests. Hence when these regions emerged from barbarism the use of iron increased. People were able to use it freely for such purposes as armor, nails, and plows, for which it had previously been too expensive. In the days of Queen Elizabeth the demand for iron became so great that laws had to be passed to prevent the forests from being wholly consumed as fuel in iron furnaces.

At this stage another geographical condition became important. England, northern France, Belgium, and Germany contain great deposits of coal located close to the iron ore. In England, soon after 1600 A.D., people discovered that by converting coal into coke they could use it for smelting. The rapid adoption of this method so increased the available supply of iron that such large machines as the steam engine could be turned out in large numbers. The ability of modern civilization to use iron for tools and machinery is one of the chief causes of the contrast between ancient civilization with its emphasis on art, literature, philosophy, religion, and government and modern civilization with its emphasis on science, on man's material betterment, and on the use of natural resources through manufacturing, transportation, commerce, and mining. The great civilization of the future will place equal emphasis on the idealism of the ancients and the materialism of the present.

**Where Iron Ore is Most Favorably Located.**—Countries like the United States, England, Germany, and France, where coal and iron are both abundant, have a tremendous advantage. Countries like Sweden and Spain, which have plenty of ore but little coal lose much of this advantage. They have to send the ore to places, like England and Germany, well supplied with fuel. This is cheaper than to take the coal to the ore, for two tons of coal are needed to smelt a ton of iron ore.

Our own country is particularly favored because it has enormous deposits of both coal and iron. They are, to be sure, at a considerable distance from one another, for the largest coal beds center in Pennsylvania, while the best and largest iron deposits are in the Lake Superior region. For most of the distance between the two, however, there is cheap transportation by the waterway of the Great Lakes, and the ore can easily be carried to the fuel. Moreover, the coal is near the center of the great market of the northeastern United States, so that after the ore is made into iron it does not have to travel far before being used. During the first part of the Great War, while the other great iron-producing countries were fighting, the use of iron in America increased as never before. The excellence of both the coal and the ore in the United States will probably help the country to maintain the leadership in the iron industry which it then obtained. Over 90 per cent of the world's annual production of 1,700,000,000 tons of minerals consists of coal and iron and a third of this is mined in the United States (see Fig. 54).

**The United States Steel Corporation.**—Since iron is the most important of the materials used in manufacturing, it has led to industrial combinations of enormous size. The Great German Steel Combine controls practically the entire steel business in Germany and was long the largest business combination outside the United

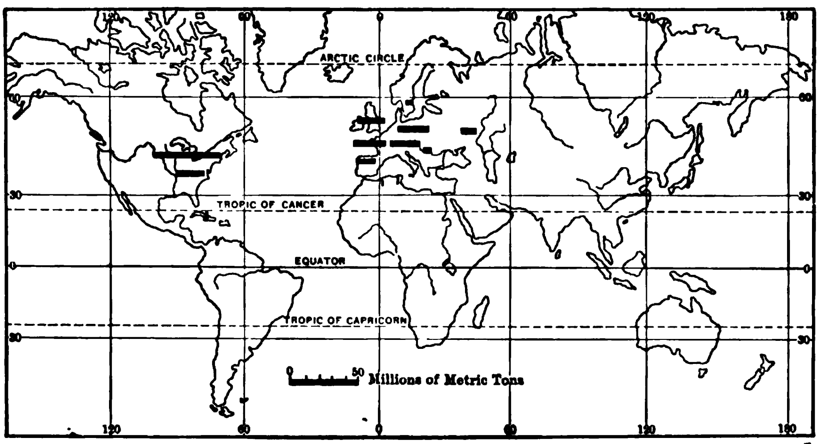



FIG. 54.—Production of Iron.

States. The United States Steel Corporation, however, is even larger. It has reached its present size because economy demands that a great number of operations in several different places should be performed under one management. In producing pig iron it is necessary first to have great ore beds in the Lake Superior district or elsewhere. Next the ore must be carried by lake and rail to the vicinity of the coal mines in Pennsylvania. Coal must be mined and converted into coke and then brought to the factory, while limestone must also be quarried. When a single company owns mines, quarries, steamboats, railroads, coke ovens, and factories it saves a great amount of waste and a large number of profits which would go to the middle man if the various raw materials and half-finished products changed hands after each operation.

Because of such advantages the United States Steel Corporation to-day controls more than half the steel business of the United States. It employs over 250,000 men distributed from Alabama to Lake Superior and from Pennsylvania to Colorado. Its 150 great manufacturing plants, its 130 iron mines, its 750,000 acres of coal lands, its 1300 miles of railway, 1400 engines, 60,000 freight cars and its 100 steamers, together with its docks, limestone quarries, gas wells, and oil wells, are worth two billion dollars, and yield a profit of between one and two hundred million dollars each year. A part, but by no means the greater part of the profits has come back to the public. For instance, Andrew Carnegie, for a long time the largest stockholder of the Corporation, gave not far from $350,000,000 for public use in libraries, scientific organizations, educational institutions, and many other forms. This is the only right course, for the profits of all such industries, although due in part to wise management, are also due partly to the fact that our laws permit private individuals to obtain control of valuable natural resources like coal and iron.

**How Copper Influences Human Progress.**—After the time when iron tools came into use at the end of the Bronze Age copper played a minor role, its chief use being for cooking vessels. Within the last half century, however, copper has again become important, for the world has learned to use electricity. Among all the common substances copper is the best electrical conductor, therefore no power plant, electric light plant, telephone, telegraph, or automobile is made without copper. In California and elsewhere copper wire now makes it possible to transmit electric power 400 to 500 miles. The need of good electrical conductors is growing so rapidly that to-day copper is the most important of all metals after iron. Eight times as much copper was produced in 1910 as in 1880, and there has been a steady increase in more recent years. In 1913 the world's production was over a million tons.

**Copper Production of the United States.**—The United States dominates the copper situation, for it produces more than half of the world's supply. It is the only great industrial country, aside from Japan, that has large copper mines. The American supply formerly came largely from the Upper Peninsula of Michigan. Oddly enough the fact that the ore there often occurs in large pieces of pure metal is a disadvantage. Copper ore can be smelted more easily than pure copper can be dug out, for the metal is so ductile that it cannot be broken by blasting. Arizona and Montana are now the chief copper States.

**The Character of a Copper Town.**—The demand for copper has led to the growth of many cities such as Butte, Montana, and Bisbee, Arizona. The surrounding regions have been thoroughly prospected and the copper industry has assumed a permanent aspect. Hence the towns have lost many of the bad qualities of the "boom" towns

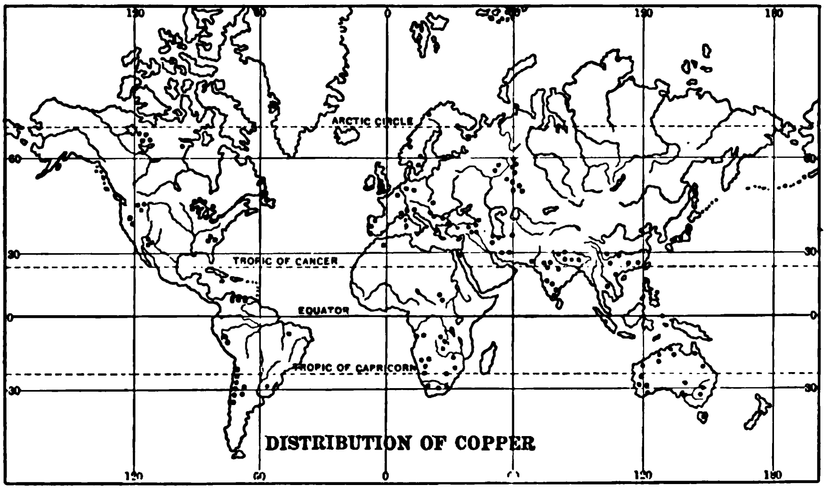



Fig. 55.—Distribution of Copper Ores.

which grow up where the precious metals are mined. A man may settle in a copper mining town with the idea of staying there for life.

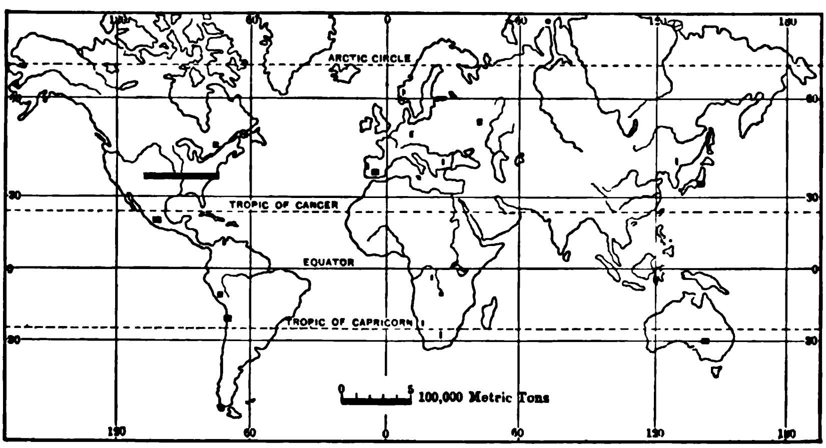



Fig. 56.—Production of Copper.

The chief drawback is that mining is a hard, disagreeable occupation. Aside from the skilled superintendents, engineers, and foremen, it usually attracts only the poorest kind of labor. Moreover, most of the copper mines are not located in agreeable surroundings, for the bare deserts of the region west of the Rocky Mountains are less attractive than the more fertile regions elsewhere. Another drawback is that the smelting of copper ore fills the air with vast clouds of sulphur, for many of the best ores are a combination of copper and sulphur. At Butte, Montana, and at other places, the sulphurous smoke is carried to heights of four or five hundred feet in great chimneys. Yet it settles down in such volume that not a tree can grow within miles of the smelters. Such conditions often drive capable people away from the mining towns, and thus retard their progress.

**Copper in Other Countries.**—The other countries where copper is abundant are Chile, Japan, Spain, Mexico, and Australia, in the order named. The Chuquicamata deposits in Chile, owned by an American corporation, are by far the largest in the world. Copper is one of Japan's chief metal products, but her total production is only about one-eighth that of the United States. Aside from Spain the countries of Europe have little copper. In the Balkan Peninsula and Asia Minor supplies are reported, but are not extensively worked. Germany's inability to get copper during the Great War was a great handicap. Ordinarily that country produces only 26,000 tons a year and consumes about 260,000 tons. During the War her need was vastly increased. The government requisitioned every available bit of copper, including trolley wires, electric light fixtures, faucets, old teapots handed down for generations, and the very roofs and bells from the churches. Even the Emperor's palace was not spared, and attempts were made to buy up the copper coins of other countries such as Norway, Sweden, and Switzerland.

**Aluminum.**—The light metal known as aluminum is a comparative newcomer. Not till about 1910 was it sold at such a price that it could be used like iron and copper for ordinary purposes. Its uses lie between those of the other two metals. Pound for pound it surpasses copper as an electrical conductor, but cannot so easily be made into wire that will not break. It is harder than copper, however, and hence in automobiles and especially airplanes it can be used for parts like the oil pan of the engine, where the strength of iron is not required and where lightness is desirable.

Luckily aluminum is contained in common clay and in a great number of rocks, so that the supply is practically unlimited. The chief drawback is that to extract it from the ores strong electric currents are required. Therefore the great aluminum plants are located where the ore occurs near powerful waterfalls such as those of Schaffhausen, Switzerland, and Niagara Falls. Savoy in France and the mountainous portions of Germany and Italy are also the seat of aluminum factories. If power could be obtained cheaply enough, aluminum would soon be used more than any metal except iron. The towns where it is made are apt to be located in pleasant

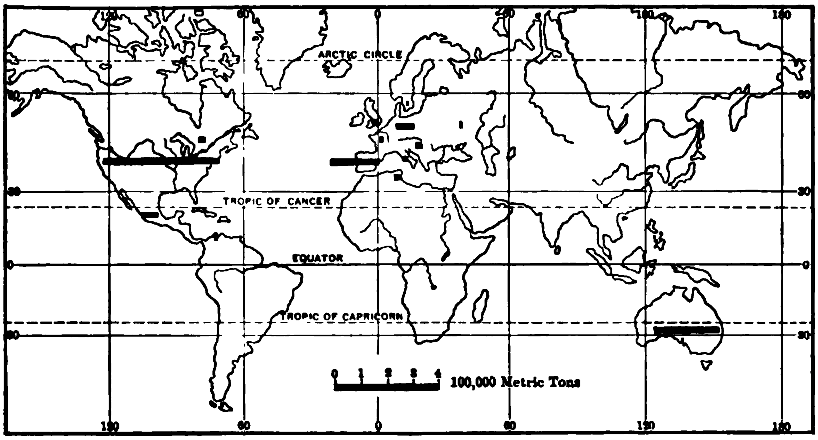



FIG. 57.—Production of the World's Lead Supply.

parts of the country, for that is where the water-power is found. They do not have a large body of low-grade laborers working underground, for the ore is taken from open quarries requiring relatively

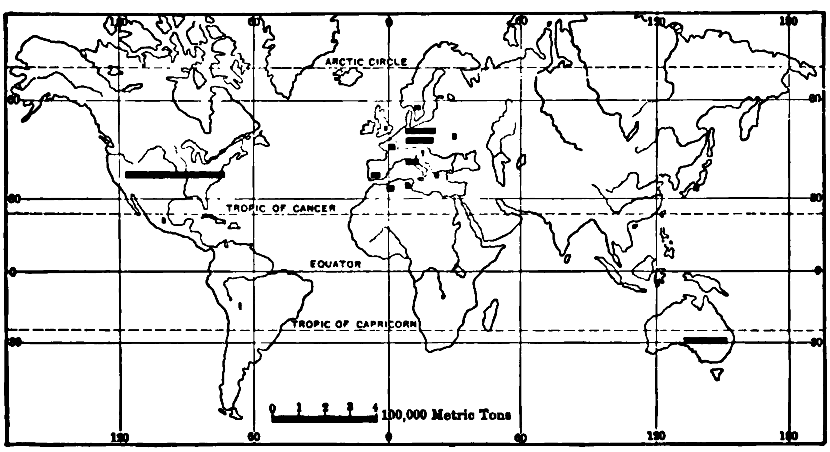



FIG. 58.—Production of the World's Zinc Supply.

little labor. Moreover, the amount of machinery and of skilled work required in the production of aluminum is unusually large. Altogether aluminum has a large number of favorable characteristics in its effects on man.

**Why We Need to Conserve our Mineral Deposits.**—Minerals far more than forests need to be carefully conserved. Forests will grow again, but when minerals have once been destroyed they can never be replaced. Among the metals discussed in this chapter gold and silver are conserved with great care, for everyone is careful not to lose the smallest bit of either. Yet they need to be conserved far less than the other metals, for they play little part in the world's work. Iron plays so great a part that our supplies of that metal are our most important mineral resource. As yet, however, they have not been seriously diminished, for there are vast quantities of low-grade ores. Aluminum is fortunately far more abundant than iron, and the supplies have as yet scarcely been touched. With copper the case is far more pressing. Its use is constantly growing, while the supplies are rapidly being exhausted. The same is true of many minor minerals, such as zinc, lead, phosphates, and tin. If they are once exhausted many of our industries will suffer seriously, and future generations will wonder how we could have been so careless.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. How do you explain the lack of mining in Denmark? In Florida?

2. Why are swindles so easily made with mining stock?

3. Why is iron more precious to man than the "precious metals," gold, and silver?

4. What effect would it have on prices if no new gold mines were to be opened for several decades?

5. How does it happen that the world's largest business combination is one that deals with iron rather than any other material?

6. How does the control of the chief metals by English-speaking countries strengthen their international position?

Put this in the form of a problem.—Make a list of six to eight chief producers of iron, copper, zinc, lead, tin, aluminum, gold, silver, platinum, mercury, antimony, bismuth, nickel, and radium. How do the United States and the British Empire compare in this respect? What nation or group of nations having the same speech comes second in controlling metals? How do the metals that they control compare in importance with those controlled by the English-speaking people?

7. Point out which of the following are desirable in order to conserve our natural resources:

(*a*) The building of ships and bridges with re-inforced concrete instead of wood or steel.

(*b*) The use of aluminum instead of copper in pots, kettles, and electrical machinery.

(*c*) The substitution of steel passenger and freight cars for those of wood.

(*d*) The use of aluminum in many parts of automobiles and airplanes in place of steel.

## CHAPTER IX

## THE SOURCES OF POWER

**Importance of Power.**—In the present Age of Steel and Electricity all sources of power have assumed a new and increasing importance. The manufacturer needs power to drive his machinery, to bring raw materials, and to carry his finished products to market. The merchant needs power to run his elevator, and supply him with light. The farmer needs it to plow his fields, saw his wood, sharpen his scythes, churn his butter, and carry his crops to market. You yourself need power to light your home, to carry you on journeys, and to bring you letters and supplies. It is clear, therefore, that everyone in a civilized community uses power either directly or indirectly. Farms, transportation systems, and factories, however, are the greatest users of power. Hence in this chapter we shall think particularly of their needs in considering the seven great sources of power (1) man's own body, (2) animals, (3) wind, (4) water, (5) wood, (6) coal, and (7) petroleum.

**Kinds of Power.**—(1) *Man.*—The oldest and most common source of power is the energy of *man's body.* He uses it to raise food, build houses, carry loads, and wield the ax. He also uses it for manufactures such as the woolen rugs of the Khirghiz and the carved toys of the Swiss.

In tropical countries man's strength is the chief source of power. For instance in India, Africa, and tropical South America long lines of coolies trudge hundreds of miles through jungle and swamp weighed down with heavy loads on their heads or backs. In China some device like a wheelbarrow is usually used to aid man's strength in carrying both goods and people; and in Japan the jinrikisha serves the same purpose to better effect. In the most advanced countries, although millions of men furnish power for transportation, unlike the coolie, they transport their loads only short distances, as in carrying bricks and mortar, loading boxes into wagons, and lifting leather into cutting machines. In our own country man's bodily power is used less than anywhere else, since its place is taken by so many devices such as elevators and electric trucks.

(2) *Animals.*—Since man's own strength is not sufficient to accomplish all his ambitious plans, he long ago obtained other sources

of power by taming the horse, donkey, ox, camel, water buffalo, elephant, yak, llama, and reindeer. His use of one or another of these animals, quite unlike his use of his own strength, is least in tropical countries and greatest in the most advanced parts of the world.

In tropical countries animals are little used for two chief reasons: (*a*) The people are not energetic and intelligent enough to take good care of their animals. (*b*) The most useful animals like the horse and ox do not thrive in tropical countries because of the poor grass and pestering insects. The fine animals introduced by the United States into the Philippines deteriorate rapidly if left to the care of the natives.

In countries like Japan and eastern China horses and other beasts of burden are also rare. The climate is not favorable to grass, and the places where food for animals might be raised are needed to supply food for the dense human population. In dry, grassy regions like the steppes of Central Asia and our own Western States, horses and cattle are numerous, for there is much land that is good for grazing and not for agriculture. Nevertheless, animals are not used for power nearly so much there as in the great agricultural regions like the eastern United States, especially Illinois and its neighbors, or northwestern Europe, especially northern France and the Low Countries. In such places horses are so valuable for farm work that their number is increasing in spite of the increased use of automobiles.

(3) *How Wind Furnishes Power.*—The sources of power thus far considered demand little or no mechanical skill. The use of wind, however, demands that people shall be inventive and able to construct machinery. Hence windmills are unknown within the tropics except where Europeans or Americans have introduced them. The steady trade winds, however, are almost ideal for wind-power. Hence in tropical towns like Merida in Yucatan, a regular forest of windmills may be seen, since most of the 65,000 people use water pumped from caverns and streams deep down in the porous limestone. The chief development of windmills, however, is in the energetic temperate zone. In level open regions like Holland, Wisconsin, and Iowa, where the wind blows freely and steadily, they are used in large numbers to pump water into tanks, and to cut wood and fodder.

Aside from windmills, sails are the chief method of using the power of the wind. In China wheelbarrows as well as ships are propelled in this way. Although wind-power is very cheap its use for ships has greatly declined, and the same is true of windmills. In 1800 all ocean vessels were propelled by the wind, for steamboats were still unknown. In 1870 the number of vessels of the two kinds in Great Britain was about equal. In 1914, just before the Great War, the steam tonnage of Great Britain was over twenty times as large as the sailing tonnage. In the United States the steam tonnage is now over ten times as large as the other. We have a large proportion of sailing vessels because they are adapted to coastwise trade, which our laws encourage, while for transoceanic trade, which our laws have rarely encouraged, steam vessels are almost universally employed. Even in our own country, however, the use of sailing vessels is rapidly declining.

The reason for the decline in the use of wind-power is that the wind may die down just when it is most needed, whereas gasoline and other engines have become more and more reliable. If one of the readers of this book should invent a cheap storage battery, it would enable the power of high winds to be saved for times when there is no wind. Such an invention would go far toward solving the great problem of how the world shall continue to have cheap power when such fuels as coal and petroleum are exhausted or have risen to exorbitant prices.

(4) *Water Power.*—This subject is considered in Chapter VI, on "Inland Waters," and should be reviewed at this point.

(5) *Wood as a Source of Power.*—The sources of power thus far considered fall into two great types, (*a*) the power derived from living beings, including both animals and man, and (*b*) that derived from the movement of air and water. We must now consider a third type, (*c*), the power obtained by burning fuel. Fuel may be burned slowly as in a fire or explosively as in a gasoline engine. The three chief forms of fuel are wood, coal, and petroleum. Let us see what special geographical conditions cause one to be used rather than the others.

Although wood was originally of great importance as a source of power, its use for that purpose has reached a low ebb in more advanced regions.

In such regions transportation systems and farmers almost never use wood for power, and factories use it only for special reasons. Furniture factories have such a reason because they can use their own sawdust, shavings, and chips.

Again at the Swedish iron works at Dannemora iron ore is smelted with wood in the form of charcoal. This is partly because the surrounding forests furnish a vast supply of wood, but chiefly because certain of the finest grades of tool steel can be made only with charcoal.

In backward regions which comprise more than half the earth's habitable surface, wood is still the chief source of power. This is the case chiefly in heavily forested regions, or else in backward countries where the difficulties of transportation make coal unduly expensive.

In the vast forested plains of northern Russia and Siberia, for example the great piles of cordwood that one sees stacked up beside the railways are fed into the locomotives and produce a shower of sparks equal to a Fourth of July celebration. In tropical regions, too, the river steamers often stop for hours on the edge of the forest to let a crowd of half-naked black men throw sticks of firewood upon the deck.

In such backward regions the factories as well as the transportation systems commonly use wood for fuel. Both in *number* and *size*; however, the factories that use wood are insignificant. For instance, in tropical countries the scattered little sugar mills, hemp factories, canning factories and rubber-smoking plants, are some of the kinds that depend upon wood or other vegetable fibers for fuel.

(6) *Coal as a Source of Power.*—If there were no coal, manufacturing could be carried on by means of wood and waterpower, but its development on a large scale would be impossible. Factories require so much fuel that on the present scale they would soon exhaust the world's wood supply. The United States mines about 600,000,000 tons of coal each year. To get an equal supply of power from wood would require one and a half billion tons of cordwood which would be three or four times as much as all the wood used each year in the United States for both fuel and lumber.

**How the Use of Coal Varies.**—(1) *Progressive Countries with Much Coal.*—The distribution of coal is highly favorable. Large supplies happen to be located in places where the people are physically active and have alert, inventive minds. The countries of the world may be divided into four groups according to the activity of the people and the abundance of coal. The first group consists of progressive countries with much coal. It includes Europe from Poland, Czechoslovakia, and Austria westward, and the northeastern quarter of the United States east of the Mississippi. Not every part of these regions has coal at its very doors, but all can bring it without difficulty and therefore share in its benefits. In England, more than elsewhere great supplies of coal, as well as iron, in the midst of a large population gave the steam engine full opportunity to develop. In proportion to its size Great Britain has much the largest and best deposits of coal in the world. The United States, to be sure, has much more coal than Great Britain, and for household use Pennsylvania anthracite is better than even the finest Welsh coal, but this country is thirty-four times as large as Great Britain. The extent to which coal is mined in various countries may be judged from the fact that Britain produces over 6 tons for each inhabitant, the United States 6, Germany 4, and Belgium 3. In proportion to their population these

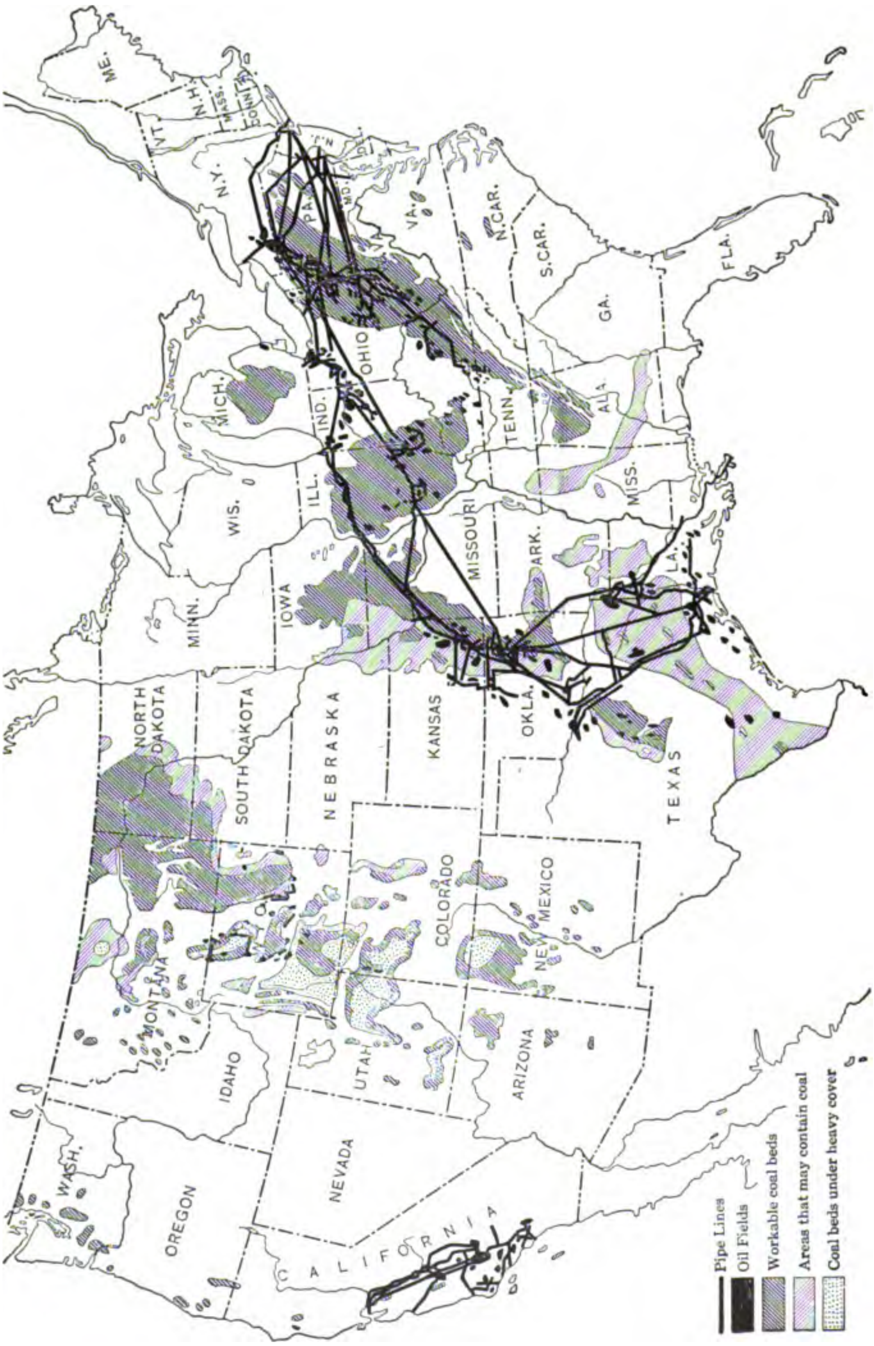



FIG. 59.—Map of Coal in the United States.

four countries are the greatest producers of coal. They are also the leading manufacturing countries.

(2) *Progressive Countries with Small Coal Supplies.*—Next in coal

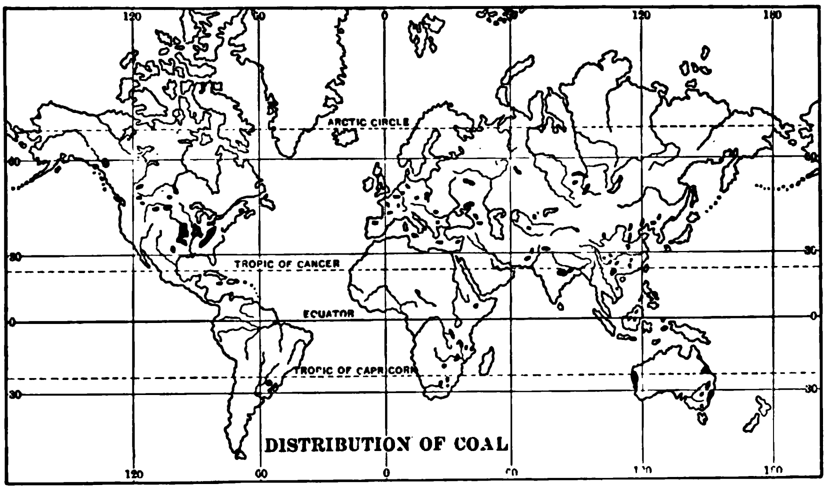



Fig. 60.—Distribution of Coal Deposits.

production to the countries just named come France, Canada and Australia with about $1\frac{1}{2}$ tons per inhabitant. Then follow Czecho-

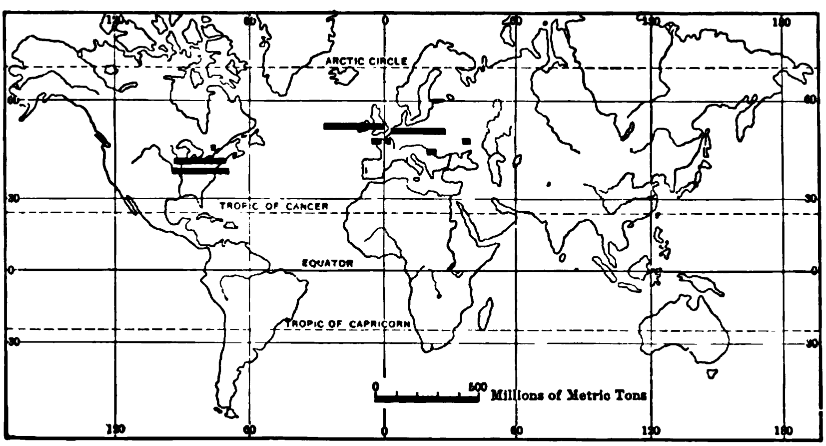



Fig. 61.—Distribution of Coal Production.

slovakia, Poland, and South Africa, with 1 ton, and Russia and Japan with only half a ton. At least portions of each of these countries are inhabited by people so wide-awake and energetic that they have developed their coal to great advantage and are thereby able to carry on a good deal of manufacturing.

(3) *Backward Countries with Much Coal.*—China, Indo-China, and Siberia have large deposits of coal, those of China being second only to those of the United States. Yet in these regions the coal has remained largely unused. Only during recent years under the influence of Europeans has it begun to be exploited. The lack of manufactures in these countries compared with the activity of manufacturing industries even in countries with limited supplies of coal such as France, southeastern Australia, New Zealand, and Japan, shows that coal alone is of little importance in developing manufacturing industries unless there are also energetic people.

(4) *Backward Countries with Little Coal.*—Tropical countries are the least favored in their supplies of coal, as well as in the character of their people. Peru and Bolivia, to be sure, have a little coal, but have never mined it extensively. India, in proportion to its population, has no more than these countries, although the presence of the English has caused it to be developed. Other tropical countries appear to have almost no coal, although there may be large supplies as yet undiscovered. At any rate, coal has had little effect on their industries.

**Conservation of Coal.**—Since coal is the most important mineral product aside from iron it should be most carefully conserved. The world is using up its coal at the enormous rate of between two and three billion tons a year. If the use of coal should continue to increase at the present rate, all the coal would be gone in 150 years. Even if the rate of increase declines and we cease to waste so much, the coal will be largely exhausted in not much over a thousand years. Then what will our descendants do? No other known fuels can fill our needs. The world's supply of peat, for example, is estimated at 13,000,000,000 tons. This sounds large, but if peat had to be substituted for coal the entire supply would be gone in six or seven years.

Fortunately much of the coal of the United States still belongs to the nation as a whole. Therefore it can be carefully guarded so that it may not be wasted or given away to favored individuals as has happened so largely in the past. Moreover, there are many ways of decreasing the waste of coal. (1) For example, in carrying coal from the mines to the factories we use an enormous amount of power in running the trains and steamships. Experiments in England and the experience of power plants in America show that by burning the coal at the mines and sending the energy economically by electricity to factories we should save all the coal consumed by thousands of freight trains as well as many other expenses, and at the same time should make our cities clean and wholesome. The same purpose would be accomplished, at least in part, by burning the coal at seaports, where it could be delivered inexpensively and sending the power to the cities of the interior.

(2) When coal is burned to run a steam engine only about 15 per cent of the possible energy is converted into power. The other 85 per cent is wasted in the heat that goes off into space. When the 15 per cent of power that is saved is used to produce light there is an enormous further waste, so that the final power used in ordinary

*By courtesy of Child Labor Commission, N. Y. City.*

Fig. 62.—Shoving Cars in a Coal Mine.

A hard, disagreeable job.

electric lights is only one-five-hundredth of the original energy of the coal. Already we are learning that gas and a liquid like gasoline can be extracted from coal and exploded in such a way that the loss of energy is much less than with the steam engine. Further inventions are possible which will prevent the enormous waste of power which now occurs when we use coal for heat and light.

(3) One of the greatest sources of waste in coal mines is the pillars and walls that have to be left in order to prevent the roof from caving in and killing the miners. Sometimes the coal thus left is recovered by "robbing" the pillars, that is, by digging them out after the rest of

the work has been done, and letting the roof cave in. In a sparsely inhabited country this process is allowable, but it is dangerous where there are many houses on the land above the mines, as it is likely to wreck their foundations when the surface slowly sinks down. In the future, however, coal is likely to be so valuable that it may be worth while to substitute concrete pillars for those of coal, and thus save millions of tons which are now wasted.

FIG. 63.—Spinning in Palestine.
An example of primitive industry where human power alone is employed.

**The Life of Coal-mining Regions.**—Although coal is of tremendous value in manufacturing and transportation, it is in some ways a hindrance to civilization because of the life at the mines. The process of breaking out the coal and loading it into little cars far underground is monotonous and tiresome. It is not particularly well paid, for it does not require much skill. Moreover, coal mining is one of the most unhealthful and dangerous occupations. The presence of coal dust and "fire damp" in coal mines impairs the miners' health by constantly obliging them to breathe polluted air. Explosions caused by fire damp, dust, and the careless use of artificial explosives cause many deaths. The greatest danger, however, is the falling of pieces of the roof and wall which often bury the miners. Hence, even more than in most industries, those who are more competent seek work in other lines where there are better opportunities to rise. Their places are taken by less competent workers, who until the Great War, came to America in a steady stream from the more backward countries of the Old World. So many immigrants thus poured in that in many mining regions where they lived by themselves it was not possible to Americanize them. They still spoke their old languages, followed foreign customs, thought in foreign ways, and believed that liberty meant license.

Under such circumstances, the conditions of homes, schools, and churches, and of social life in general cannot be the best. Strikes, too, are common. In the history of the United States the worst of all strikes have occurred in coal mines such as those of West Virginia and Colorado. Such strikes are most apt to occur in isolated communities inhabited largely by a foreign-born population. Since many miners are ignorant, both politics and social life have usually been dominated either by unscrupulous mine owners or equally unscrupulous anarchistic agitators. Since other industries are not developed, it is not easy for the miners to enter other occupations, and there is no body of skilled laborers, merchants, and other substantial people to act as a "balance wheel." Hence when strikes occur, violence is apt to be common on both sides. In several cases serious fighting has taken place, and United States troops have been brought in because the local police and even the State troops have been unable to cope with the trouble. This oft-repeated condition has led the great coal State of Pennsylvania to establish an effective State police force, or "constabulary," which is used in preventing disorder when strikes occur.

In England also the coal mines have been the scenes of some of the worst strikes. During the Great War the miners saw their opportunity to demand higher wages. A temporary strike threw the country into great alarm, for if the coal supply had been cut off, the operations of both peace and war would have been brought to a standstill. Thus it appears that while coal is the foundation of modern industry, the actual work of mining the coal is a hindrance to civilization.

**Petroleum and Natural Gas.**—(1) *Why They are Easily Obtained.*—Although petroleum and natural gas have been known from early times, their common use for light and heat did not begin till about 1860, and for power till near the end of the century. Among the world's important fuels petroleum and natural gas are (1) the most easily obtained, (2) the most easily distributed (3) the most varied in their uses, and (4) the most easily exhausted. They are easily obtained because when holes are drilled in the deep-seated rocks where they accumulate the pressure causes them to well up. Often oil and gas gush out so violently that the well-drilling tools fly high in the air, and the flow cannot be checked for weeks or months. Such "gushers" sometimes take fire. When oil was struck at the San Bocas well in the Tampico oil field ot Mexico in 1908 the oil that gushed out caught fire from the drilling engine. It burned 57 days, consuming 175,000 barrels of oil a day, and wasting material worth $3,000,000. The flame was 800 to 1400 feet high and gave so much light that a newspaper could be read by it at night 17 miles away. Such a well, when properly capped, is worth thousands of dollars a day.

When such huge returns are possible from the insignificant labor of drilling a well, it is not surprising that the search for oil has been carried on with the same eagerness as that for gold. When new oil territory is opened, prospectors rush in to get hold of the best sites, and there is all the reckless excitement, quarreling, and trickery which occur during stampedes for gold. The first days of the California and Texas oil-fields, for example, were marred by great lawlessness.

(2) *Why Petroleum and Gas Can Easily be Transported.*—Petroleum can be transported cheaply because it can be pumped into tank cars or tank steamers as easily as water. It can also be pumped through pipes for hundreds of miles, thus giving it the cheapest possible mode of transportation. Pipe lines to-day run not only from the oil fields in Pennsylvania and Illinois to New York, but from Oklahoma to Chicago. In Asiatic Russia a pipe line runs from the Greak Baku oil field on the Caspian Sea to Batum on the Black Sea. Gas, too, is piped hundreds of miles. Throughout large areas of Pennslyvania, West Virginia, and Ohio almost every house is supplied with natural gas which is used for cooking, heating, and lighting. The gas does not even have to be pumped, for with the aid of compressors it is carried along by the pressure of the well behind it.

(3) *The Varied Uses of Petroleum.*—Much the greatest uses of petroleum are for power and light. In some cases it is burned in its crude form. For instance, in the southwestern United States and southeastern Russia oil-burning locomotives are used, not only because the railroads are near the oil-fields of Oklahoma, Texas, California, or Baku, but because oil can be employed more easily than coal, since it does not need a stoker. Many warships are oil-burners because of the ease and speed with which this kind of fuel can be put aboard. Even in mid-ocean during a storm or a battle a

warship can renew its supply of petroleum by pumping the liquid from a tender through a hose. As a source of light petroleum is used all over the world. City people often fail to realize this, but among farmers and in backward countries kerosene is the main source of light.

In its use for power petroleum possesses a great advantage because it can not only be burned, but exploded, thus giving power without the intervention of a boiler and steam. Everyone is familiar with its use in this way in automobiles, where the refined petroleum product known as gasoline is employed, but crude oil can also be used in the same way in the Diesel engine.

As a lubricant the effect of petroleum upon the development of power is fast coming to be almost as important as its effect as a fuel. Modern methods of utilizing many kinds of power demand high, speed machinery like dynamos, motors, automobile and airplane engines, and many machines in factories. Such machinery must be lubricated with high-grade oils, and petroleum is the only good source of such oils. Hence without petroleum many of our present uses of power would be impossible.

(4) *Why Petroleum Should be Used Sparingly.*—By its very nature petroleum tends to rapid exhaustion. At first, when a source of oil is tapped, the gushers often waste a great deal, later they merely flow gently, next they cease to flow naturally, and must be pumped, and finally the wells that are pumped give a smaller and smaller output. A well that lasts a generation is rare. In spite of the drilling of new wells, the yield of the Pennsylvania field has fallen from 33,000,000 barrels in 1891 to only 7,000,000 in 1917. Pennsylvania, which in 1890 ranked as the world's greatest producer, was in 1917 exceeded by Oklahoma, California, Texas, Illinois, Louisiana, Kansas, West

PETROLEUM PRODUCTION, MILLION BARRELS

| | 1903. | 1909. | 1913. | 1917. | Per cent of World Production 1917. |
|---|---|---|---|---|---|
| United States | 63.0 | 182.0 | 248.4 | 335.3 | 66.7 |
| Russia | 75.0 | 65.0 | 60.9 | 70.0 | 13.9 |
| Austria (Galicia) | 5.7 | 14.9 | ........ | 5.5 | 1.1 |
| Roumania | 1.6 | 9.3 | 13.5 | 6.0 | 1.2 |
| British India | 1.0 | 6.6 | 7.5 | 8.5 | 1.7 |
| Dutch East Indies | 2.2 | 11.4 | 11.9 | 12.7 | 2.5 |
| Japan | 0.8 | 1.8 | 1.0 | 2.9 | 0.6 |
| Mexico | ........ | ........ | 25.6 | 55.3 | 11.0 |
| World Production | ........ | 285.0 | 381.6 | 503.0 | .............. |

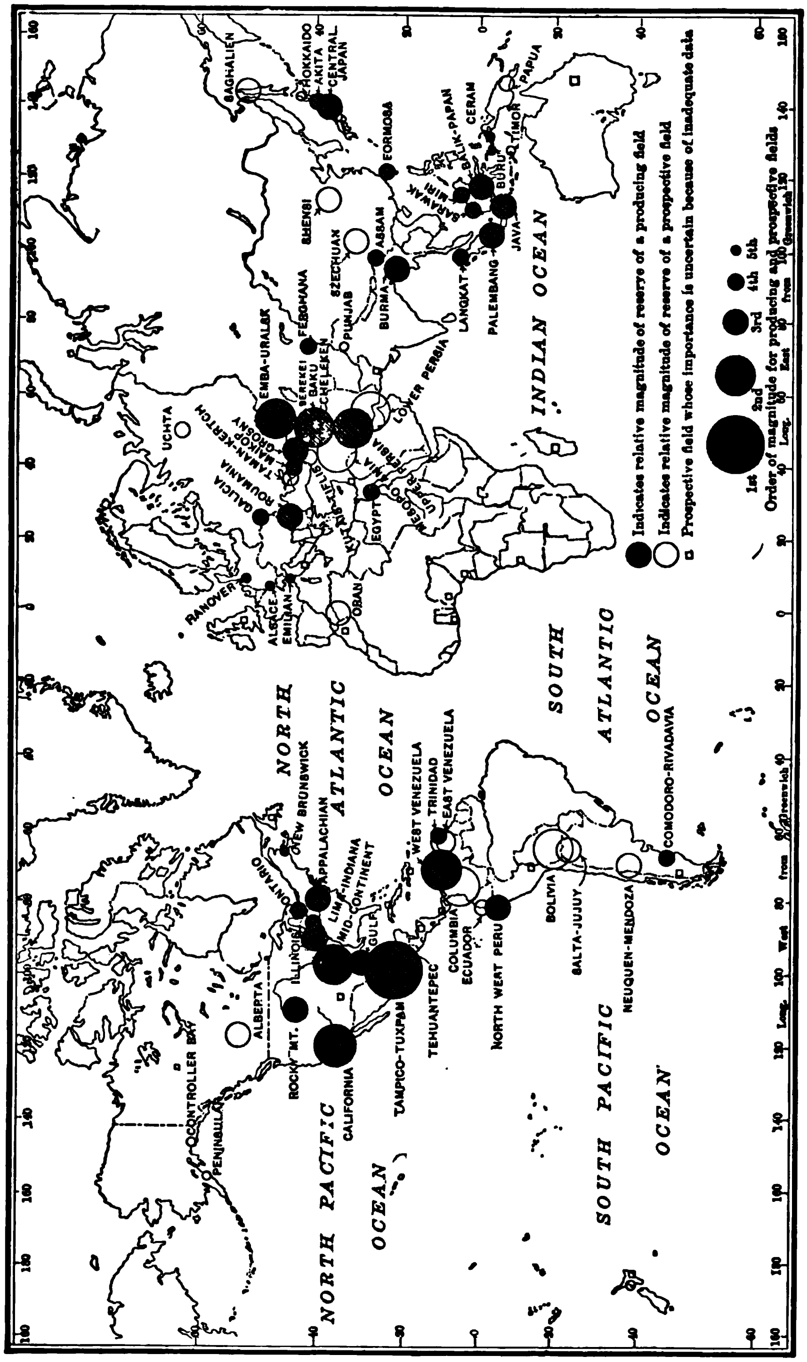



FIG. 64.—Distribution of Petroleum Supplies.

Virginia and Ohio among the American States, as well as by foreign regions such as the Tampico and Baku fields. The way in which production changes is well illustrated in the table on page 197.

The demand for petroleum, especially for automobiles and for lubricants, is increasing enormously. If the present conditions continue it will be only a few decades before the supply will be largely exhausted. So far as fuel is concerned this will not be serious, for wood alcohol made from the abundant vegetation of the torrid zone can take the place of gasoline, and coal can do all that is done by the cruder forms of petroleum. For lubricants so essential to power, however, we know of no good substitute. If they should become scarce and high priced it would cause great inconvenience and expense. It is a serious question whether the country ought not to take steps to prevent the consumption of oil where other substitutes

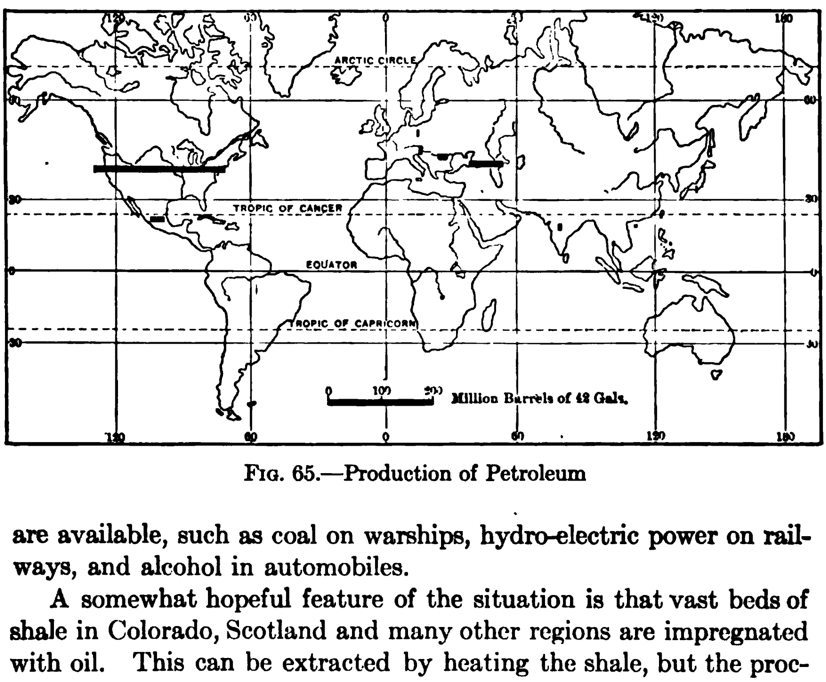



FIG. 65.—Production of Petroleum

are available, such as coal on warships, hydro-electric power on railways, and alcohol in automobiles.

A somewhat hopeful feature of the situation is that vast beds of shale in Colorado, Scotland and many other regions are impregnated with oil. This can be extracted by heating the shale, but the process is costly. Hence Scotland is the only country where there has thus far been large production, and the oil shales will probably be available long after the liquid petroleum is largely exhausted.

**How Petroleum Influences Human Activity.**—In its effect on man the geographical distribution of petroleum is much less important than the distribution of coal. If its value for fuel had been known earlier it might have caused manufacturing cities to grow up where it occurs, but now this rarely happens. This is partly because petroleum is so easily transported, and partly because towns in oil-producing regions are generally disagreeable. Even the better residential portions usually smell of oil, while the parts where most of the people must work are very dirty and greasy. Slimy, oil-covered pools are scattered among black, forbidding derricks. Another reason why manufacturing centers do not grow up around oil wells is that such places are not permanent. Like "boom" mining towns, they usually grow for a few decades and then decay as the oil gives out.

The most important effect of petroleum upon man is the way in which it has led to two great improvements in machinery: (1) It has made all sources of power much more effective by making it possible to use high-speed machinery, requiring cheap, heavy lubricants. (2) It has led to the invention of the light engines which are necessary for the automobile and especially the airplane. If there had been no such thing as cheap, easily combustible kerosene and gasoline it is doubtful whether we should have had these means of transportation for generations. When the world's petroleum is practically exhausted and its place taken by alcohol and other substances still to be invented, future generations will still owe to petroleum one of the most important advances in transportation.

**An Example of the Political Effect cf Petroleum.**—The high value and limited distribution of petroleum make all the great nations eager to secure new supplies. This is especially true of countries like England and Germany, which have little or none within their own territories. Even if countries have an abundance at home, however, their business men are eager to find new supplies, for the development of new fields is extremely profitable. Hence when a wonderfully productive oil region was discovered on the northeast coast of Mexico near Tampico, Americans, British, Germans, Dutch, and other foreigners all hastened to get control of as much land as possible. The production of oil increased so rapidly that although it was negligible in 1910, Mexico to-day stands next to the United States as an oil producer, and the Tampico region produces more oil than any other area of equal extent.

The oil fields of Mexico are highly important for that country itself as well as for the foreigners who use the oil or who make fortunes by exploiting it. Since Mexico has little coal, the oil is by far her greatest fuel. It is used not only for some of the factories, street car lines and lighting systems, but for about half the railways. Still more important from the Mexican standpoint is the fact that taxes on oil lands and on exported oil are one of the main sources of the government's revenue.

Because of these facts there has been much conflict between three sets of people, each wishing to get as much as possible from the oil fields: (1) the foreign exploiters who have acquired title to the lands and have invested much money; (2) the Mexican government, which feels that it must impose heavy taxes in order that Mexico may get its fair share of the great wealth that keeps flowing out of the ground; and (3) Mexican bandits and rebels, who also want a share in this wealth and sometimes terrorize the workers at the oil fields, rob and even kill the paymasters and others, and thus compel the oil companies to pay large sums for protection. The Mexican government has sometimes been unable to prevent this or to punish the offenders. Such complications lead some people to say that people from the United States have no right to exploit the resources of their more backward and less competent neighbor, while others say that this country ought to intervene and give Mexico a good government.

In certain respects the relation of Japan to the coal mines of China is like that of the United States to the oil of Mexico. In such cases the fact that a backward country contains wonderfully rich supplies of a valuable source of power gives rise to one of the most complex of the political problems that confront the League of Nations.

**The Standard Oil Company.**—Petroleum occurs in such a way that a few people can easily obtain control of a large part of the product. When this happens, great economies can be practiced and prices can be kept up so that enormous fortunes are made. The history of the Standard Oil Company illustrates the matter. That Company, though now broken up into a number of supposedly independent concerns, holds its place as one of the largest industrial organizations in the world. In this country only the United States Steel Corporation exceeds it. Time and again it has driven rivals out of the market. It has done this largely because it could produce oil more cheaply than its rivals and could utilize every possible by-product, such as vaseline, paraffine, benzine, and a hundred others. Moreover, in the early days it obtained special railroad rates or entered the territory where a competitor made its sales and put the prices so low that the other company had to go out of business. Then prices were raised and the great Standard Oil Company got back what it had lost during the period of competition. Being protected from competition in the United States by peculiar tariff regulations, the company kept prices at a high level in this country and sold much cheaper abroad than at home. In order to meet competition in foreign markets the company also acquired interests in other countries. In these various ways and also by wise management it acquired 85 or 90 per cent of all the oil business in the United States Thus since about 1880 it has distributed more than a billion dollars in dividends and has also acquired a vast amount of property which has been paid for out of profits.

The reason why the Standard Oil Company has become so strong is not that it owns all the oil wells, for it owns much less than half, but because it controls transportation. Almost everywhere it has succeeded in preventing the construction of any pipe lines except its own. Since transportation by pipe lines is far cheaper than by rail, independent producers can rarely make a profit unless they can use pipe-lines. Therefore they have had to sell their product to the great company which dominated the business and would not serve them otherwise. Fortunately some of the leading men not only in the Standard Oil Company but in other lines of business feel that at least part of the wealth derived from great natural resources and from the growth of population belongs to the community and not to themselves. Therefore considerable sums of Standard Oil profits have gone back to the public in the form of endowments to such institutions as Chicago University, the International Health Commission, and the great Rockefeller Foundation.

**How Power May be Obtained in the Future.**—In spite of all possible economies and inventions the time will surely come when new sources of power will be needed. Man-power and animal-power have long been insufficient. The space available for raising wood decreases as the world's population becomes more dense. Coal and petroleum are rapidly being exhausted. Among the sources of power now used only the wind and running water can be counted on as permanent sources of abundant power. It is estimated that when proper dams and reservoirs are built the streams of the United States may possibly supply more than 100,000,000 horse-power. At present our factories and transportation systems use about 30,000,000 horse-power; the heat used in houses, and the power used on farms, in automobiles, and for all manner of minor purposes probably brings the total up to 50,000,000. Thus if the water-power could all be utilized it would suffice for the present, but our population is growing with great rapidity, and the amount of power needed per individual is also increasing by leaps and bounds. Hence if we have 200,000,000 people in 1970, we shall probably need much more than 100,000,000 horse-power for all purposes including heat and light. Similar conditions will probably prevail in other countries. Thus even when all the water-power has been harnessed, the world will ultimately need much additional power to heat its houses, cook food, carry on industries, and keep transportation systems in operation.

Part of this can perhaps be obtained from the wind, but the greatest source of power is the sun. In the drier part of Texas, where the sky is usually cloudless, any two average counties among the 245 in the State receive from the sun enough power to run all the factories and transportation systems in the whole of the United States. If we can devise means of using sun-power directly and cheaply, one of the world's greatest problems will be solved. To-day steam can be made in solar steam engines whose boilers are heated by concentrating the sun's rays upon them by means of mirrors. Such engines, however, are too expensive to be practicable, and can be used only in places where the sun is rarely clouded. The engineer who invents a solar engine that is practical and cheap, and that has sufficient storage to carry it through cloudy days, will do mankind a most wonderful service. When that is accomplished, we may hope at last to get rid of our strike-breeding coal mines except as places from which material for dyes, medicines, and so forth is extracted. We might also get rid of the factory chimneys that pollute the air of our cities. Perhaps our factory towns will be as clean and wholesome as are those in Switzerland and elsewhere that now use hydro-electric power. We may be able to extract aluminum cheaply and in enormous quantities and thus conserve less abundant metals such as iron and copper. We may perhaps pump water for irrigation so cheaply as to cultivate many dry regions that now are almost uninhabited. We may be able to heat our houses electrically with as much ease as we now light them. Think of the work and dirt that would be saved in that one way! The cost of transportation and of manufactured goods will be lessened, for now one of the largest items, especially in transportation, is the cost of coal. In short, if ever solar energy should become cheaply and easily available, life might be revolutionized almost as much as it has been by the invention of the steam engine, and the change would in most respects be beneficial.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Make a list of ten industrial plants near your home, including at least one power plant. Classify them according to (1) the source of power; (2) the use to which the power is put; (3) the distance and method by which the power is transmitted; (4) the relative cost of the power and the reasons for choosing each particular kind.

2. In Switzerland tourists are surprised to see even the most primitive cottages lighted by electricity. List six other parts of the world where a similar development is likely to take place. Arrange these in the order in which you think an investment in water power would be profitable, and give your reasons.

3. Make a map of all the routes of transportation in your home district. Show the method of transportation by the character of the line used; for example: railroads, a solid line; trolleys, a double broken line; automobile roads, a dotted line;

wagon roads, a line of dashes. Color the lines according to the kind of power employed. Compare the routes according to (1) topography; (2) their value to the community; (3) the difficulties of construction.

4. Make a tracing of a map showing the coal fields of Europe. Also trace from a population map the most densely populated parts of Europe. Compare these two maps and interpret them. Contrast the density of population in the Russian coal fields and in those of Alsace and Belgium. Explain the difference.

5. Make similar tracings for Great Britain. Pick out five centers of dense population and explain how they differ in their relation to the sources of power.

6. Express the production of petroleum in various countries in the form of a graph.

7. Make a map of the world showing by different shadings or colors the kinds of power that are most common. Explain your map in terms of geographical environment.

# PART VI

## *MAN'S RELATION TO CLIMATE*

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## CHAPTER X

## CLIMATE AND THE CLIMATIC ZONES

### A. Why Climate is Important

Climate is the most important of all the geographic factors. It acts upon man in three chief ways: (1) It sets up barriers which limit his movements. (2) It determines the supply of most of the materials needed, not only for food, but for clothing and shelter. (3) It has a direct and important influence upon health and energy.

(1) *How Climate Acts as a Barrier on the Ocean.*—Climate limits man's movements directly when a rainstorm keeps people in the house for example, or a gale prevents ships from going to sea. Its chief effects, however, are indirect or in combination with other factors. For example, a large part of the difficulty in crossing oceans and mountains is climatic. America did not remain undiscovered so long merely because of the broad ocean, but because people feared that climatic conditions in the form of storms and winds would wreck them or prevent them from coming home again. To-day travelers do not fear the ocean when it is calm, but only when it is disturbed by climatic influences such as winds, waves, fogs, and icebergs like that against which a great ship called the *Titanic* struck her bows and sank with 1500 people. The effectiveness of the ocean as a barrier would be greatly reduced if the climatic dangers could be eliminated.

**How Climate Sets up a Barrier among Mountains.**—In the same way the barrier of the mountains is largely climatic. For instance, in crossing the Himalayas from India to western China the steep slopes and thin air are indeed a great hindrance. Yet these direct effects of relief are far less dreaded than are the climatic conditions of low temperature, nipping wind, and fierce snowstorms, followed by the blinding glare of the sun. Worse still are the climatic conditions that cause avalanches which sometimes bury whole caravans, and glaciers where man and beast sometimes plunge to their death in deep crevasses. Worst of all is the absence of vegetation, because the climate is so cold that on vast stretches of high barren plateau no one can dwell and not even grass can grow. It is so difficult to bring food there that among the caravans on the way from India to western China, hundreds of weakened animals die each year from hunger and exposure. In a single day's journey a traveler counted 32 dead horses that had recently fallen by the trail; the next day he counted 220; and the third day 474, in addition to one human corpse. All that was due to the cold climate acting either directly through storm and wind, or indirectly through the absence of vegetation.

**How Climate Bars the Way within the Frigid Zone.**—The climate of cold regions erects barriers even more impassable than those of mountains and oceans. The world's largest unexplored areas are the snowy plateaus of Antarctica and Greenland and the bitterly cold regions of northern America and Asia. So impassable are the great fields of snow and ice that the poles were not reached till the present century in spite of attempt after attempt. Peary reached the North Pole and Amundsen the South only after long experience had taught explorers how best to use dogs and other means of transportation, how to carry and store great supplies of food and fuel, and how to provide the warmest clothing and shelter.

**How Climate Acts as a Barrier in Deserts.**—Next in difficulty to the climatic barrier of cold regions come hot, dry deserts. In southern Arabia the desert climate makes such a barrier that no explorer has ever penetrated a region hundreds of thousands of square miles in extent. The natives fear this region not only because there is no water, but because of the extreme difficulty of climbing the lofty dunes of dry, sliding sand piled up hundreds of feet by violent winds. When the wind dies down the dust settles in the low flat areas between the dunes. As no rain falls for years at a time the dust becomes so deep that one sinks in it above the ankles even on the edges, and every movement raises it in stifling, choking clouds. No one dares go farther for fear of sinking deeper and then falling and being smothered.

**How Climate Sets up a Barrier in Tropical Forests.**—The damp heat of tropical forests creates a barrier to human movement almost as serious as that of deserts. Not only does such heat cause the growth of dense forests through which travel is almost impossible, but it is most exhausting to human energy, and fosters some of the world's most deadly fevers. Even so wise and vigorous an explorer as Theodore Roosevelt was baffled by the barrier of the South American forests, and could not escape the ravages of tropical fever. Thus on

*By courtesy of F. Ellerman, Mt. Wilson Observatory, Pasadena Calif.*

FIG. 66.—A Snow Storm on Mount Wilson, Calif.

**To illustrate the effect of both altitude and latitude on climate.**

Fig. 67.—On the Coast of Cochin China.

A region where the tropical jungle and the rain forest both prevail. Here the tropical types of life are fully developed.

oceans, among mountains, in deserts, and in both high and low latitudes such climatic conditions as high winds, intense cold, extreme aridity, and damp tropical heat, are among the circumstances most unfavorable to man's movement from place to place.

(2) *Climate and the Food Supply.*—The effect of climate on man's material needs can best be illustrated by considering the food supply, for materials for clothing and shelter vary from place to place in the same way as food. Climate, more than anything else, determines the nature and abundance of vegetation and hence of man's food supply. People who have spent their lives among the forests and meadows of a moist temperate climate such as prevails in the eastern United States often feel as if such vegetation prevailed everywhere. Similarly a person who has always lived in a dry climate is likely to think that all parts of the world consist of thriving irrigated orchards and fields surrounded by barren land with only a few scraggly bushes and tufts of dry grass. The man who lives among the forests and meadows may raise cattle, oats, turnips, and potatoes. The man in the dry climate may raise grapes, oranges, wheat, and celery. These examples illustrate how greatly food may vary in response to the climate.

Variations in the food supply in their turn have much to do with people's habits. Since the Eskimo, for instance, lives in a climate which almost forbids the growth of vegetation upon the land, but not in the sea, he must catch sea animals for food. Therefore he is a good hunter and a bold fisherman, and wanders far and wide upon the water. He is as much at home in his *kayak* as upon the land. The Fiji Islander, on the other hand, lives in a climate where a few bread-fruit trees or cocoanut palms furnish food for himself and his family without work. That is one reason why he is lazy and effeminate and spends most of his time sitting idly at home.

(3) *Climate in Relation to Health and Energy.*—Man's health and energy are influenced by climate both directly and indirectly. In the temperate zone everyone knows that some days the air is invigorating and on others depressing. Most people work slowly on hot, muggy days, for if they work fast the result is unusual weariness. On a clear bracing day in the autumn, on the contrary, we often feel as if we could do anything no matter how hard. Still later, on a cold winter day, we sometimes run to keep warm, but in the house we feel a little dull and stupid. Thus in many ways our activity of mind and body is influenced directly by climate. That is one chief reason why tropical races have never made much progress. Their climate is too warm. On the other hand, such people as the Chukjees of northern

Asia are made stupid and their progress is retarded because their climate is too cold.

Climate also influences the body indirectly, especially through diseases. When negroes or other tropical races change their climate by coming to the North they are liable to suffer from consumption, pneumonia, and similar diseases of the lungs. In tropical countries the diseases encouraged by the climate are far worse. There the climatic conditions favor many disease-bearing insects such as the *anopheles* mosquito, which carries malaria, and the *stegomaria* mosquito, which carries yellow fever. How bad the tropical diseases are may be judged from the account of a recent traveler in the Amazon Basin. He speaks of the change in some of his comrades after only two weeks in the steaming, insect-infested forest. "Several of them were already suffering from violent attacks of malaria, and their faces were colorless and sallow; others who had been in the region longer stared at our boat with sunken, lusterless eyes in which not even a vestige of interest in our visit or of hope was evident; a few had apparently reached the stage where the sight of the twelve newly made graves on the hill-top no longer aroused feelings of dread or apprehension, but rather of indifference tempered with longing for a welcome release."

**The Varying Nature of Climate.**—Among the five great elements of physical environment climate is by far the most variable. The location of a place cannot vary; the land forms and water bodies do not change perceptibly during many generations; and neither the soil nor minerals change appreciably except where man intervenes. Climatic conditions, on the contrary, are constantly changing. In the temperate zone a downpour of rain is followed by cloudless skies to-morrow; a warm, muggy day by one that is crisp and bracing.

Some winters are long and so cold that much snow accumulates; others are short and open. One year may be warm and wet, and the crops abundant; while the next year is so dry that the farmers can scarcely raise enough to make a living. Even in tropical and polar regions there are marked differences between different years, although the variability is not so great as in the temperate zone.

Climatic variations last through long periods as well as short. Perhaps twenty-five or thirty thousand years ago occurred the climax of the last glacial epoch. Ice several thousand feet thick covered much of northwestern Europe and most of North America north of the Missouri and Ohio Rivers. Since that time the climate has changed so that most of the ice has melted and some of the places which it covered have become the most progressive parts of the world. The change, however, has been irregular, for sometimes the climate has for a time tended to go back to the former glacial conditions, and then has become even more mild than at present. Altogether we may say that climate is *the* variable factor in geographic environment. With every climatic variation, whether it be a great change lasting thousands of years or a little seasonal variation from one year to another, or from month to month, there is a corresponding change in vegetation, in animals, and in man.

## B. How Climatic Zones Originate

**The Controlling Climatic Factors.**—The first step in understanding climate is to know why it differs from place to place. These differences depend on four factors: (I) the earth's rotation, (II) the revolution of the earth and the inclination of its axis, (III) the distribution of land and water, and (IV) the relief of the lands. Let us take each of these four factors separately and consider its effect upon temperature, pressure, winds, and rainfall.

**How Rotation Affects the Distribution of Temperature.**—In order to understand the effect of rotation, let us for the present ignore the other three factors. Let us suppose that the earth's axis has no inclination, and that the relief and the distribution of land and sea have no effect. With such a simplified globe the sun's movement through the heavens would at all times follow the course it now follows at the equinoxes. Hence there would be no seasons. For the reasons pointed out in Chapter II the equator would always be the warmest part of the earth, and the temperature would decline steadily toward the poles.

**The Distribution of Pressure.**—The most prominent feature of the distribution of atmospheric pressure on the earth as a whole is the more or less regular rise of pressure from polar regions to approximately latitude 30°. Since the days of *Ferrel* this has been supposed to be due to a circumpolar whirl arising from the westerly winds which make an eddy with a depression in the center like a whirlpool in water. This explanation, however, is so doubtful that for the present we may think of a steady increase in pressure from equator to poles as the normal condition on a simple rotating planet with a uniform surface.

This simple distribution of pressure, however, would be altered by the temperature conditions described above. The high temperature of equatorial regions causes the air there to expand. Hence, if the atmosphere had an upper surface, as we may say for convenience, the heat would raise this surface well beyond the level that it would occupy under the influence of rotation alone. Such bulging would not in itself cause a change in pressure, for the total amount of air would be the same after expansion as before. As a matter of fact, however, a portion of the overbulging air flows away just as water flows from the center of a great fountain where the supply wells up from below. The air that flows away from the equatorial bulge moves northward or southward, but not east or west, because there the same bulging occurs. So much air flows from the equator that the pressure at the

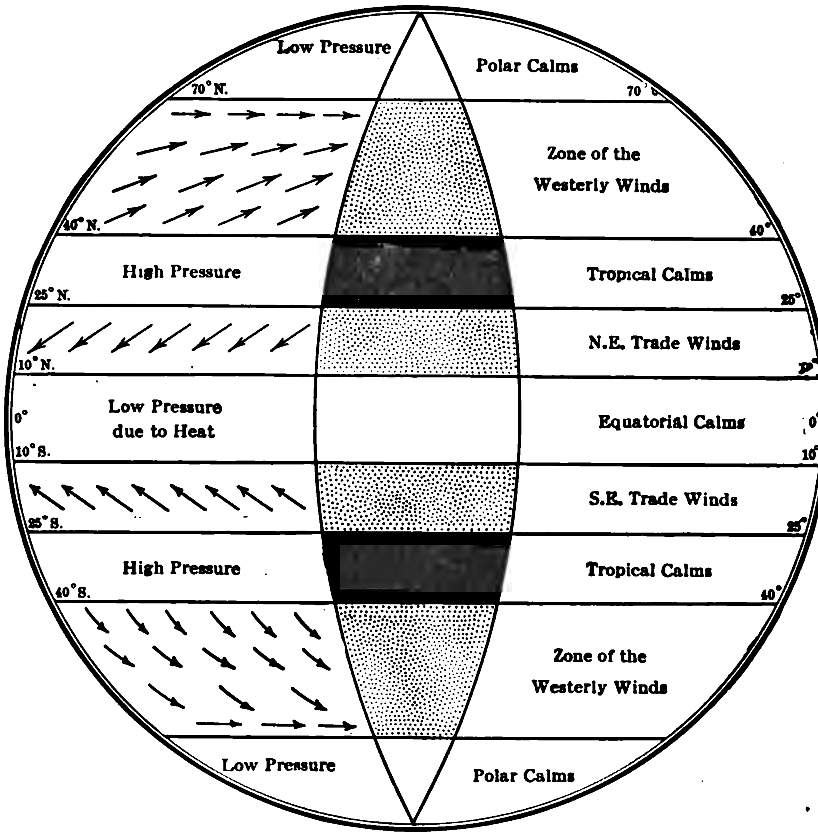



FIG. 68.—Pressure Belts on a Simplified Globe

earth's surface decreases. Hence an *equatorial belt of low pressure* is formed as shown in Fig. 68.

In the latitude of the tropics and a little farther poleward so much air is added by the flow from the equator that the pressure is increased, forming a *subtropical belt of high pressure* in each hemisphere. Farther poleward the air that has risen in equatorial latitudes gradually descends giving rise to westerly winds. These circle round the earth in a great whirl which reduces the pressure in high latitudes. Thus a simplified globe would have an equatorial belt of low pressure between two subtropical belts of high pressure, while in high latitudes there would be *two polar areas of low pressure.*

**How Winds Would Blow on a Simplified Globe.**—Let us now see how the pressure belts would influence the winds on our simplified globe. Their distribution is shown in Fig. 68. We will begin with the subtropical belts of high pressure because they are the starting point of two of the earth's chief types of surface winds. The weight of the upper air in the regions of high pressure causes the air to settle slowly downward, but the movement is so gentle that it cannot be felt. Hence the subtropical high-pressure belts form regions of *calms*, the " horse latitudes," as they are called.

On the borders of the subtropical belt of high pressure the downward movement in the central region forces the air outward and forms regular winds on the earth's surface. These blow toward the equatorial belt of low pressure on one side and toward the polar area of low pressure on the other. In the warm equatorial belt of low pressure, as we have seen, the air is heated and expands so that part flows away at the top. This reduces the mass of the air so much that the cooler, heavier air from the neighboring high pressure areas is able to push in below and lift the warm, light air. This cooler air is in turn warmed and pushed up. Thus an ascending current of air is formed in the equatorial belt and there are no steady winds. In other words this ascending current is accompanied by equatorial *calms* just as the descending current is accompanied by subtropical calms.

**How Rotation Influences the Direction of the Winds.**—Although the winds that blow out from the subtropical high-pressure area start toward the equator and the poles, the rotation of the earth gradually deflects them. In the northern hemisphere the deflection is toward the right and in the southern toward the left. Thus in the northern hemisphere a wind that starts toward the pole from the northern side of the subtropical belt is gradually deflected to the right until it becomes a southwesterly wind, that is it blows from the southwest, for winds are always named from the direction whence they come. Further deflection causes such a wind to become westerly, as is shown in Fig. 68, and even northwesterly. Thus it happens that on the northern side of the northern subtropical belt of high pressure there is a belt of prevailing "Westerlies." Similarly the air pressed out from the southern subtropical belt toward the south pole starts as a north wind, but by deflection to its left becomes a northwest and finally a west wind. This gives rise to a belt of " Westerlies " in the southern hemisphere as well as in the northern.

Let us go back now to the northern hemisphere. On the southern side of the northern subtropical belt the air starts equatorward as a northerly wind. It is deflected to its right just as in the westerlies. Hence it blows as a northeast wind. The direction and steadiness of such winds have caused them to be called the "Northeast Trades." In the southern hemisphere similar winds start equatorward as southerly winds from the subtropical belt, but because of a left-handed deflection become southeast winds. This with their steadiness gives them the name of "Southeast Trades." *

The regularity and strength of the trades is so great that for centuries sailing ships from England and France have found it to their advantage to go south to the trade wind zone in order to be blown westward to America. On the return voyage, on the other hand, if a ship started from Florida, for instance, it went north at first in order to get out of the trade winds into the westerlies which would blow it back to Europe. With the increasing use of airships the direction of the wind is becoming of still greater importance. It is worth while for an airship to go hundreds of miles out of its direct course in order to find favorable winds.

The discovery of America was made easier because Columbus happened to get into the trade winds which blew him across the ocean. The first airships to cross the ocean, on the contrary, used the westerlies instead of the trades because they wanted to cross where the ocean was narrow. Hence in 1919 when Englishmen were trying to forestall Americans in being the first to make a trans-Atlantic flight they brought their airships by steamer to Newfoundland in order to fly with the prevailing winds.

The westerlies and the trades together with the regions of calms give rise to nine wind belts. In the center lies the equatorial belt of low pressure, rising air and calms. On the north side of this belt lie the northeast trades and on the south the southeast trades. Next to them come the two subtropical belts of high pressure, descending air, and calms. Still farther toward the poles come the westerlies blowing generally from the southwest in the northern hemisphere and from the northwest in the southern. Finally around the poles we have two areas of irregular winds and calms.

*Zones of Rainfall on a Rotating Globe.*—On a simplified rotating globe the zones of rainfall would correspond to the belts of temperature, pressure, and winds that have just been described. Rain occurs because air is cooled. Everyone knows that warm air can hold more

* To understand the deflection of the winds by the earth's rotation, suppose yourself to be in the northern subtropical belt of high pressure. Face the equator and begin to walk southward, but as you proceed, turn more and more to your right. Your course will correspond to that of the northeast trades. Repeat the experiment to represent the southeast trades, and the westerlies of each hemisphere, remembering that the earth's rotation causes deflection to the right in the northern hemisphere and to the left in the southern.

moisture than cold.* That is why wet shoes dry so much better beside the kitchen stove than in the woodshed. When air rises the pressure upon it decreases because there is less air above it. Therefore it expands, and in so doing grows cool. When we fill a tire with a handpump we notice that the pump cylinder gets hot, for the compression of air develops heat. Conversely when air expands it loses heat and grows cool. Thus rising air becomes cool. It gives up moisture in the form of clouds, much as warm, moist air gives up dew when it touches a pitcher of ice water and thus causes the pitcher to "sweat." Hence clouds are formed and rain falls upon any part of the earth where the air rises sufficiently.

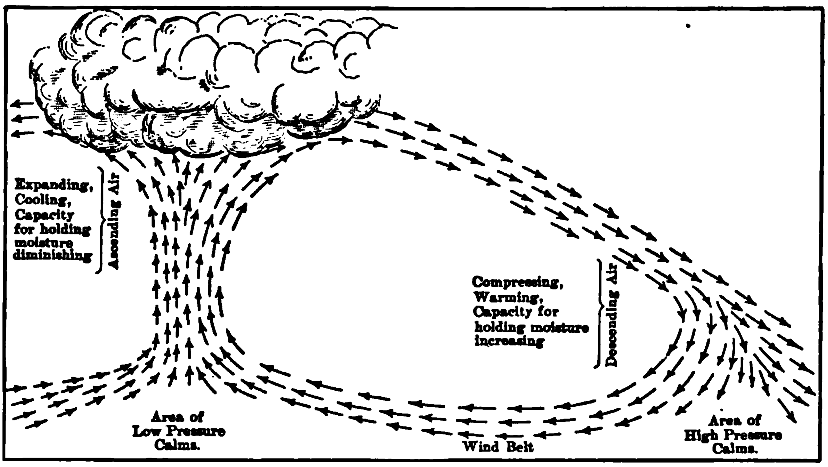



Fig. 69.—Diagram of Rising and Cooling Air.

Vertical scale so exaggerated that one mile occupies as much space as a thousand miles horizontally.

**Rainfall of the Equatorial Belt of Low Pressure.**—In no other part of the world does air rise so steadily and so abundantly as in the equatorial belt of low pressure. Therefore this is the region of greatest rainfall. Fig. 69 shows what happens there. During the rainy season of the equatorial belt, the mornings are usually sunny; clouds gather toward noon, showers fall in the early afternoon, and then the air clears. So regularly does this happen that people count on it, and plan accordingly. "Let's play tennis an hour after the shower," one man may say to another.

**Rainfall of the Trade Wind Belts.**—Since the air in the trade wind belts moves horizontally its capacity for moisture suffers prac-

* In reality the air does not hold the moisture, for the particles of both water vapor and gas are so small and far apart that they fly about in the same general area and interfere with one another very little. It is *space*, not air, that holds water vapor, but the expression used in the text is so common that it is employed here and elsewhere.

tically no change because of increase or decrease of pressure. Some change, however, arises from the fact that on its way toward the equator the air moves from cooler to warmer parts of the earth's surface. Therefore the air gradually grows warm and the capacity of space to hold moisture is increased. Hence the probability of rain grows less and less. That is one reason why the Sahara is so arid.

**Rainfall of the Subtropical Belts of High Pressure.**—Poleward from the drying trade winds the air descends in the subtropical belts of high pressure and calms. Therefore, like the compressed air in an automobile pump this air grows warmer. Hence the amount of water vapor that can be mingled with it constantly increases and when the dry air reaches the earth's surface what moisture it finds on the ground is eagerly evaporated. Thus a dry belt is produced and the subtropical regions are among the driest parts of the world.

**Rainfall of the Belt of Westerly Winds: Cyclonic Storms.**—In the belts of westerly winds the air moves horizontally part of the time. This movement may cause a little rain because the air is moving from lower to higher latitudes and hence is growing cool. The chief reason for the abundant rainfall of the belts of westerly winds, however, is that they are regions of cyclonic storms. Such storms are areas of low pressure, 500 to 1000 miles or more in width. The winds blow toward the centers of such areas, but not directly, for they are deflected to the right in the northern hemisphere and to the left in the southern. This causes the air in such areas to move spirally in great whirls and hence gives rise to the term cyclonic which means wheel-like. Sometimes cyclonic storms of small area and great severity occur in the trade wind belt. These tropical cyclones are called "hurricanes." Tornadoes, also, which are often wrongly called cyclones, are cyclonic in character, but cover only a small area and are very severe. Some thunderstorms are of the same kind, but less severe. By far the most important cyclonic storms, however, are those which cause the ordinary changes of weather in the United States, Europe, Japan, Argentina, New Zealand, and other parts of the belts of prevailing westerlies.

Ordinary cyclonic storms, or cyclones, as they may properly be called, are always associated with anti-cyclonic areas or anti-cyclones. These are areas of high presssure which may be 500 to 1000 miles in diameter or may sometimes cover a continent. The high pressure of anti-cyclonic areas causes the winds to blow outward in all directions. These out-blowing winds naturally move toward the low-pressure areas of the cyclones. Both anti-cyclones and especially cyclones are carried forward in the general drift of the westerly winds. Sometimes the center of a cyclonic storm moves 1000 miles in a day while at other times it moves only a few miles.

**How Cyclones and Anti-Cyclones Influence the Weather.**—The passage first of cyclones and then of anti-cyclones over a place gives rise to frequent changes of weather. Since the cyclones are areas of low pressure their conditions resemble those of the equatorial belt of low pressure. Their passage is accompanied by a gentle upward movement of the air, and by clouds and rain. That is why the word cyclone means almost the same thing as storm. Because of the high pressure in anti-cyclones, on the other hand, the air there descends, just as in the subtropical high-pressure belt. Hence it becomes relatively warm and its power to hold moisture increases. Therefore anti-cyclones are marked by clear weather. Anti-cyclones are often cooler than cyclones, especially in winter. This is because the clear skies permit heat to be radiated rapidly during the long nights, and because the air usually moves from higher to lower latitudes. Moreover, sometimes the loss of heat at high levels is so great that the air may come down cool in spite of the heat due to compression.

Cyclones and anti-cyclones are of the utmost importance to man. The cyclonic storms trouble the farmer in summer because they bring rain when he wants to get in his hay. They trouble the railroads in winter by piling up deep drifts of snow. They bring heavy rains which make floods like those which at various times have almost annihilated such towns as Johnstown, Pennsylvania, and Dayton, Ohio. Yet in spite of these disadvantages, cyclonic storms are one of the best things that a country can have, for they bring rain at all seasons. In the same way anti-cyclones are both a trouble and a blessing. They trouble the peach grower in New Jersey, for example, by bringing frosts when the trees are in blossom. They do great good, however, because in combination with cyclones they cause constant changes of weather and these are one of the best aids to health and a great stimulus to work.

**Rainfall of Polar Regions.**—The two polar belts might be expected to have much precipitation in the form of either rain or snow, because the pressure is low. As a matter of fact, however, they have little because the air is so constantly cold that it can absorb little moisture. Hence when the air rises in storms it yields only slight precipitation.

**How the Earth's Revolution and the Inclination of its Axis Affect the Climatic Belts.**—If the earth's axis were not inclined to the plane of the orbit in which the earth moves around the sun, the climatic belts would always remain in the location shown in Fig. 68. Hence there would be no seasons. Since the axis is inclined, however, and the vertical rays of the sun migrate back and forth from latitude $23\frac{1}{2}°$ S. to $23\frac{1}{2}°$ N, the heat equator and with it all the climatic belts migrate similarly and cause seasons. These, as we have seen, produce a profound effect upon man's life. If the sun stood always at its most southerly position the climate of the northern United States would permanently become almost like that of the Poles, and only people like the Eskimos could live there. If the sun stood always at its most northerly position conditions would not be quite so bad, but the heat of July would prevail all the year, and people would become as lazy as those of the tropics.

The effect of the migration of the climatic belts upon rainfall is especially interesting. It causes the rainy season to come in summer in some places and in winter elsewhere, and thus determines which regions are the best for farming. Suppose you had a choice between a farm in northern Texas and one in northern California, each farm being in the center of a plain where the soil is excellent, but where irrigation is expensive. Suppose also that you knew that both places had the same rainfall, an average of 20 to 25 inches a year, and the same temperature, an average of about 60° F. for the year as a whole. In Texas and California there are places of just this kind. What kind of farming would you plan in each case and how would you expect to live? If you were wise you would ask the Weather Bureau at Washington for monthly rainfall records of each section. You would find that Texas lies far enough south to receive abundant summer rains while this part of California is in the subtropical belt of winter rains. Hence during the six months of the growing period from April to September the Texas farm would get 16 inches of rain and the California farm only 4. Unless you could spend a large sum to bring water for irrigation this particular California farm would be of value chiefly as a cattle range, while on the Texas farm you could raise excellent crops of corn as well as other farm products.

**Why Equatorial Regions have Two Wet and Two Dry Seasons.**— Fig. 70 illustrates the effect of the seasonal migration of the earth's climatic belts upon rainfall. The shaded areas indicate the rainfall month by month throughout the year in various latitudes. To begin with the equatorial belt in the center, notice that in January there is almost no rain. The sun is then so far south that the equator is under the influence of the northeast trades with their drying effect. As the sun moves northward the abundant equatorial rains come with it. Hence the rainfall increases. It reaches a maximum in April or May, a month or more after the sun has passed the equinox, for the seasons usually lag a little behind the sun. Then as the sun goes northward to the Tropic of Cancer, the rainfall once more diminishes. The belt of southeast trades swings over the equator and in July there is almost no rain.

As the sun and the accompanying rain belt move southward once more, the rainfall at the equator increases until after the September equinox, only to diminish as the equatorial belt passes southward and the northeast trades again prevail at the end of the year. Thus at the equator, although there is no summer or winter, there are four

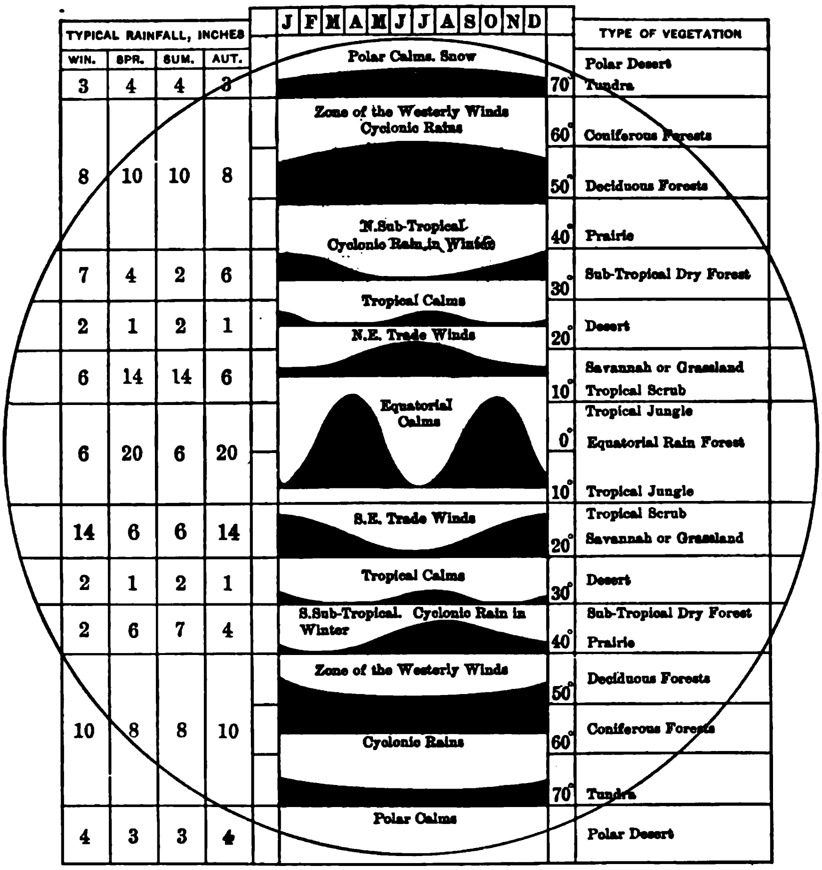



FIG. 70.—Diagrammatic Plan of Seasonal Rainfall and of Vegetation on an Ideal Globe.

seasons: (1) the dry season when the sun is in the south, (2) the wet season when the sun crosses the equator northward, (3) the dry season when the sun is in the north, and (4) the wet season when the sun crosses the equator on its way south. This type of rainfall with two wet and two dry seasons prevails almost unmodified in the equatorial regions of South America, Africa, and the East Indies.

**Why Sub-equatorial Regions have One Wet and One Dry Season.**—In the two diagrams (2N and 2S in Fig. 70) illustrating the conditions of rainfall in the trade wind latitudes 15 to 20° from the equator quite a different seasonal distribution is seen. These latitudes are near the margin of the equatorial belt, and hence are called sub-equatorial. When the sun is far south in January it carries the equatorial rain belt with it, so that the southern sub-equatorial regions receive a heavy rainfall as appears in Fig. 70. On the other side of the equator, however, the southward migration of the climatic belts causes the drying trades to blow over the sub-equatorial regions and gives them a dry season in January, as is shown in the figure. Six months later the conditions are reversed. Since the sub-equatorial belts lie in such low latitudes that they are always warm, they really have two seasons, wet and dry. Southern Mexico, northern Australia, and a strip of northern Africa just south of the Sahara have this type of rainfall.

**The Seasons of the Desert Belt.**—The third type of rainfall, tropical calms in our diagram, is that of the desert belts 25 to 30° from the equator. When the sun's rays are vertical near the equator these latitudes in both hemispheres lie in the belt of subtropical high pressure or else on the borders of the trade winds. Hence they receive no rain. They are warm, or more often hot, at these times, because the sun's rays are only slightly oblique, and the sky is unclouded. In January the climatic belts swing so far south that the northern desert belt may be touched by the edge of the westerlies, and hence occasionally receives a little rain. At the same time the southern desert belt is touched by the edges of the equatorial rainbelt. Thus the desert belts have two brief periods of slight rain. This gives four seasons, (1) a slightly rainy winter with pleasant temperatures, (2) a hot, dry spring or "fore-summer," (3) a hot summer with a little rain, and (4) a dry, hot autumn, or "after-summer." Southern Arizona and central Arabia are good examples of this type.

**Why Subtropical Regions Have One Wet and One Dry Season.**—In the next diagrams we come to the subtropical regions. Here in latitudes 30 to 40° the belt of high pressure and aridity rules during the summer of each hemisphere, while in winter the belt of westerlies swings equatorward and gives rain from frequent cyclonic storms. Notice how the curves for the two hemispheres in this and all other cases are really the same except that the seasons are six months different. Thus the subtropical rains of the northern winter in January correspond to the rains of the southern winter in July. California and such Mediterranean countries as southern Italy, Greece, and Palestine are good examples of the subtropical type in the northern hemisphere, while Cape Colony and central Chile are of the same kind in the southern hemisphere.

**The Seasons of Temperate Regions.**—The next diagrams represent the fortunate temperate regions where westerly winds and cyclonic storms prevail, and there is plenty of precipitation, that is, either rain or snow, at all seasons. There the seasons depend upon changes of temperature and not of rainfall. The northern and eastern United States and western Europe, together with Japan and New Zealand, are the chief examples of this type. The people who live there are always talking about the weather because it keeps changing. This is quite unlike the dry belts, where little is said about the weather, because it is almost always clear. There the water supply is one of the chief subjects of conversation. The abundance of water at all seasons in regions of cyclonic storms makes it possible for farmers to live everywhere. People do not have to be crowded into compact villages near the central water supply as they do in dry countries. They live where they choose, even though it be miles from neighbors. This has helped to make the people of such regions more resourceful and better able to take care of themselves than are those of other parts of the world.

**Even Distribution of Polar Precipitation.**—Finally well toward the poles we find precipitation throughout the year, but chiefly in summer, as may be seen in Fig. 70. The amount is small because cold air cannot hold much moisture.

With certain modifications due to the continents and their relief the rainfall of any part of the world belongs to one of the types shown in Fig. 70. When these types are understood one can easily judge of the probable nature of the seasons in any part of the world. Thus one can appreciate the effect which the seasons are likely to have upon farming and other industries about which he reads, and also upon his own pleasure if he travels in distant regions.

### Questions, Exercises, and Problems

1. How has climate ever served as a barrier to your movements in July? in January? in March? in April?

2. How does it happen that the best residential sections of many manufacturing cities of the United States lie in the western quarter of the city?

3. In which climatic zone would power from wind mills be most reliable?

4. Trace a map of the Atlantic Ocean and insert the route of Columbus on his first voyage to and from America. Add arrows to show the direction of the winds in the climatic belts which he traversed. What relation was there between the winds and his success? Find out about the duration as well as the location of his return voyage and of later voyages, and determine the relation of these facts to the winds.

5. Discuss the seasonal changes throughout the year on an ideal globe in the following latitudes: 10° N., 20° N., 30° S., 45° N., 60° S. Draw diagrams showing how the rainfall and temperature would vary from month to month in each latitude.

6. It is said that sailors can sometimes dip fresh water from the ocean surface in equatorial regions. How can you explain this possibility?

7. Draw diagrams illustrating the seasonal march of temperature and precipitation, that is, the conditions from month to month, in places having the temperature and precipitation shown in the following table:

| | A | | B | | C | | D | |
|---|---|---|---|---|---|---|---|---|
| | Temp. | Precip. | Temp. | Precip. | Temp. | Precip. | Temp. | Precip. |
| Jan. | 30° | 2.5 in. | 74° | 0.4 in. | 60° | 0.5 in. | 78° | 0.0 in. |
| Feb. | 31° | 2.3 | 75° | 0.6 | 63° | 1.2 | 77° | 0.0 |
| Mar. | 40° | 2.6 | 77° | 1.0 | 68° | 0.4 | 72° | 0.5 |
| Apr. | 50° | 2.8 | 79° | 1.5 | 75° | 0.0 | 65° | 1.4 |
| May | 58° | 3.0 | 81° | 2.5 | 80° | 0.1 | 58° | 3.0 |
| June | 68° | 3.1 | 79° | 8.0 | 83° | 0.4 | 54° | 4.2 |
| July | 72° | 3.1 | 77° | 15.0 | 85° | 1.3 | 50° | 4.5 |
| Aug. | 71° | 3.3 | 78° | 11.0 | 84° | 0.8 | 50° | 3.2 |
| Sept. | 66° | 3.0 | 79° | 6.0 | 82° | 0.2 | 53° | 2.5 |
| Oct. | 55° | 2.8 | 77° | 4.0 | 75° | 0.0 | 62° | 1.0 |
| Nov. | 42° | 2.6 | 75° | 1.5 | 68° | 0.0 | 70° | 0.2 |
| Dec. | 35° | 2.6 | 74° | 1.0 | 64° | 0.4 | 74° | 0.0 |
| Av. | 51°.5 | | 77°.1 | | 73°.9 | | 63°.3 | |
| Total | | 33.7 in. | | 52.5 in. | | 5.3 in. | | 20.5 in. |

Locate each of these places in its proper latitude on a simplified globe, and describe the temperature, pressure, winds, and rainfall of the zone in which it lies. For help in this use Figs. 70, 71, and 72.

8. What would be the probable climatic conditions of your own home if the earth neither rotated nor revolved around the sun? What would be the probable result if the earth revolved round the sun but did not rotate?

9. Plot rainfall and temperature curves of four places of which you know the climate by experience. Give ten practical results of the seasonal changes of climate in these places during your experience.

# CHAPTER XI

## THE CLIMATE OF CONTINENTS AND OCEANS

### A. The Effect of Land and Sea

(1) *How Oceans and Continents Influence Temperature.*—The simple arrangement of the climatic belts considered in the previous chapter and shown in Fig. 70 must now be modified to show the influences of (*a*) the distribution of land and sea, and (*b*) mountains and plains.

The land and the sea differ greatly in climate. This, as we have seen, is because land becomes hot under the sun's rays much more rapidly than does water, and likewise cools much more rapidly. This is evident to anyone who goes to the seashore either in summer or winter. In June a dweller in Minneapolis may leave his home at a temperature of 90° for a trip to Europe. Three days later in the same latitude on the Atlantic he may want his overcoat in a noon temperature of only 55°. The ocean water still retains something of the cold of winter.

It is not necessary to go so far, however, in order to note the contrast between land and sea. Often the summer air is cool and bracing close to the seashore, while ten miles inland it is hot and depressing. On the coast of central California at places like Monterey people jokingly say that in summer they must go into the interior to get warm. The ocean is so cool and west winds blow from it so steadily that the thermometer stays between 55° and 70° even when there are temperatures of over 100° one or two hundred miles away in the great interior valley, where the land has yielded to the influence of the hot summer sun.

In the winter the contrast is the other way. A boy from central New York, for example, may leave his companions coasting on deep snow in January. At Boston in the same latitude, he may find bare ground and not even any skating. This is not because Boston has less precipitation than central New York, but because it lies on the seacoast and in winter is kept at a higher average temperature than the interior by occasional winds from the ocean.

Since the lands in summer become warmer than the oceans and in winter colder, the change from one season to the other must be greater on the continents than on the oceans. This is illustrated by a comparison of Figs. 71 and 72, which show *average* temperatures in January and July.

**Marine versus Continental Climates.**—(*a*) *The Uniform Marine Climate of the Lofoten Islands.*—Let us compare an extreme *marine* climate with an extreme continental climate in the same latitude. The southern Lofoten Islands off the coast of Norway, and Verkhoyansk in Siberia, probably furnish the greatest contrast to be found anywhere between places lying at equal distances from the equator. Both are within the Arctic Circle. Yet in winter the winds blowing from the ocean prevent the Lofoten Islands from suffering the usual Arctic severity of such latitudes. Grass remains green and cattle are pastured out-of-doors all the year. In summer, however, although the weather is milder than in winter, the temperature of the ocean is so nearly the same as in winter that the islands are raw and chilly. So cool is the air that practically no trees and crops will grow, and the people wear the same thick, warm woolen clothing summer and winter alike. The great characteristic of the marine climate of the Lofotens is its uniformity.

(*b*) *The Extreme Range of the Continental Climate at Verkhoyansk.*—Verkhoyansk is so different from the Lofoten Islands that one can scarcely believe that both places are in the same latitude and no farther apart than Portland, Maine, and Portland, Oregon. At the Siberian town the range from the average January temperature to the average of July is 120° F., while in the Lofotens it is only 20°. At Verkhoyansk the temperature has been known to fall to 90° below zero, and almost every year it goes down to −70 or −80°. In fact the average for the whole month of January is about −60°. It is so cold that a steel skate, so it is said, will not "take hold" of the over-hardened ice, but slips on the surface.

Strange as it may seem, the summer at Verkhoyansk is warmer than in the islands off the Norwegian coast. This, of course, is because the land of the continental interior yields quickly to the summer sun. The *average* temperature in July is 60°, or as high as the *highest* ever known in the Lofotens, where the July average is only 51°. Temperatures as high as 85° have been recorded at Verkhoyansk, while 75° to 80° is common during the long days of summer. Hence some trees grow in spite of the intense cold, and crops can be raised, although none will grow on the Norwegian islands. To be sure, the ground never really thaws. If a man digs down a foot or so in his vegetable garden in July or August he comes to frozen soil, for only a thin layer on the surface ever melts.

In a place like Verkhoyansk not only the changes from season to

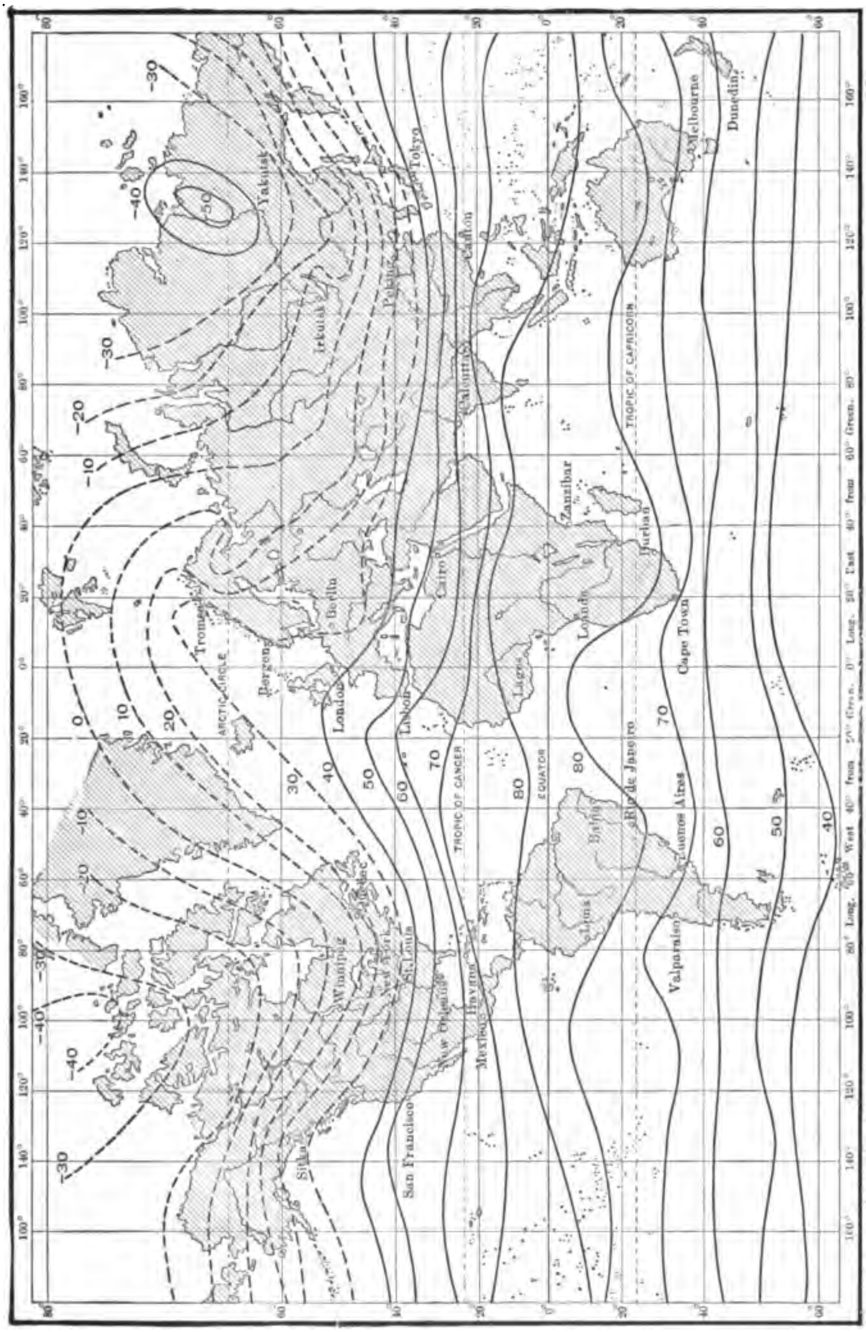
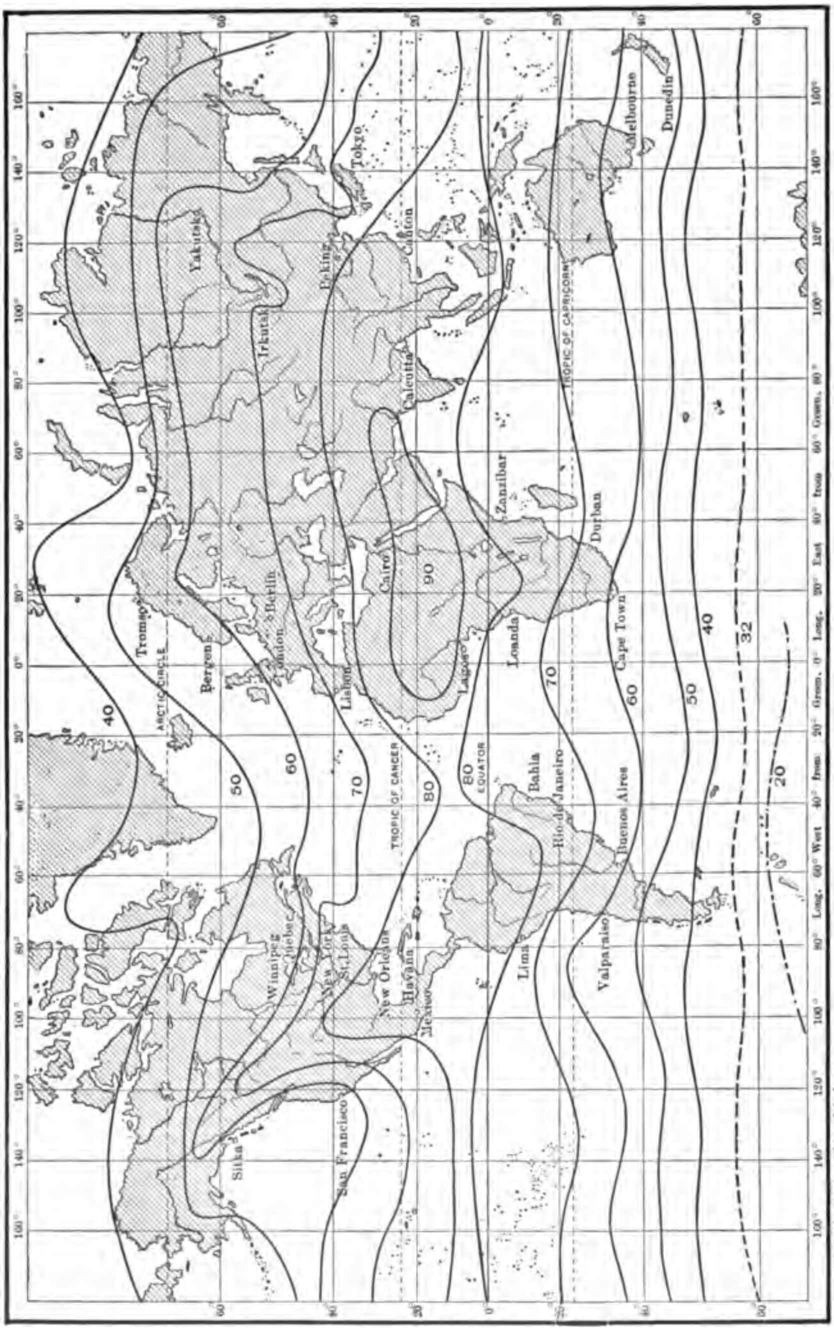



FIG. 71.—Mean Temperature of January.




------ indicates 32° and below

FIG. 72.—Mean Temperature of July.

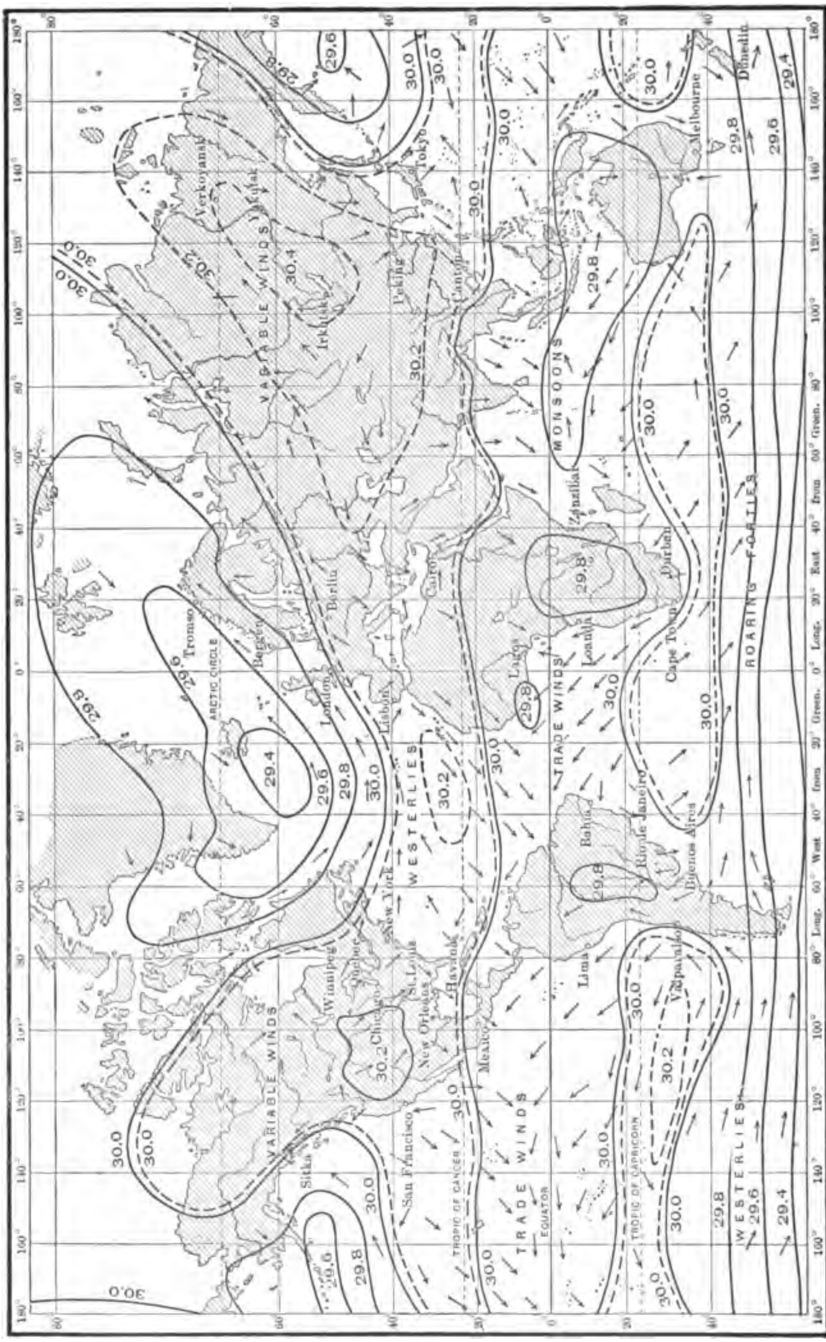
season but from day to night are often extreme. Out of doors on a March night one wants all the fur coats he can get, and even then one's nose may freeze during a short walk. The next noon, however, the warm sun and still air make it possible to chop wood with bare hands. By day in August light clothing is sufficient, but at night frosts may occur.

Verkhoyansk and the Lofoten Islands represent the extremes of continental and oceanic climates, but many other regions show somewhat similar conditions. In the typical continental climate the winter is long and cold, and the summer long and hot, with brief transition periods in fall and spring. The typical oceanic climate has a mild winter and a cool summer, with no sharply marked transition seasons.

(2) *How Continents and Oceans Affect Pressure.*—Since the continents and oceans alter the distribution of temperature, they must also alter the atmospheric pressure. As the continents grow warm in summer the air expands. Therefore at high levels it flows away from the lands and accumulates over the cooler air of the oceans. This gives low pressure in summer over the lands and high over the oceans. In winter the opposite occurs. The lands become cold much faster than the oceans. Therefore the air over the lands contracts, while that over the water remains expanded. Accordingly some of the upper air moves from the oceans to the lands. The result is low pressure in winter over the oceans and high pressure over the lands.

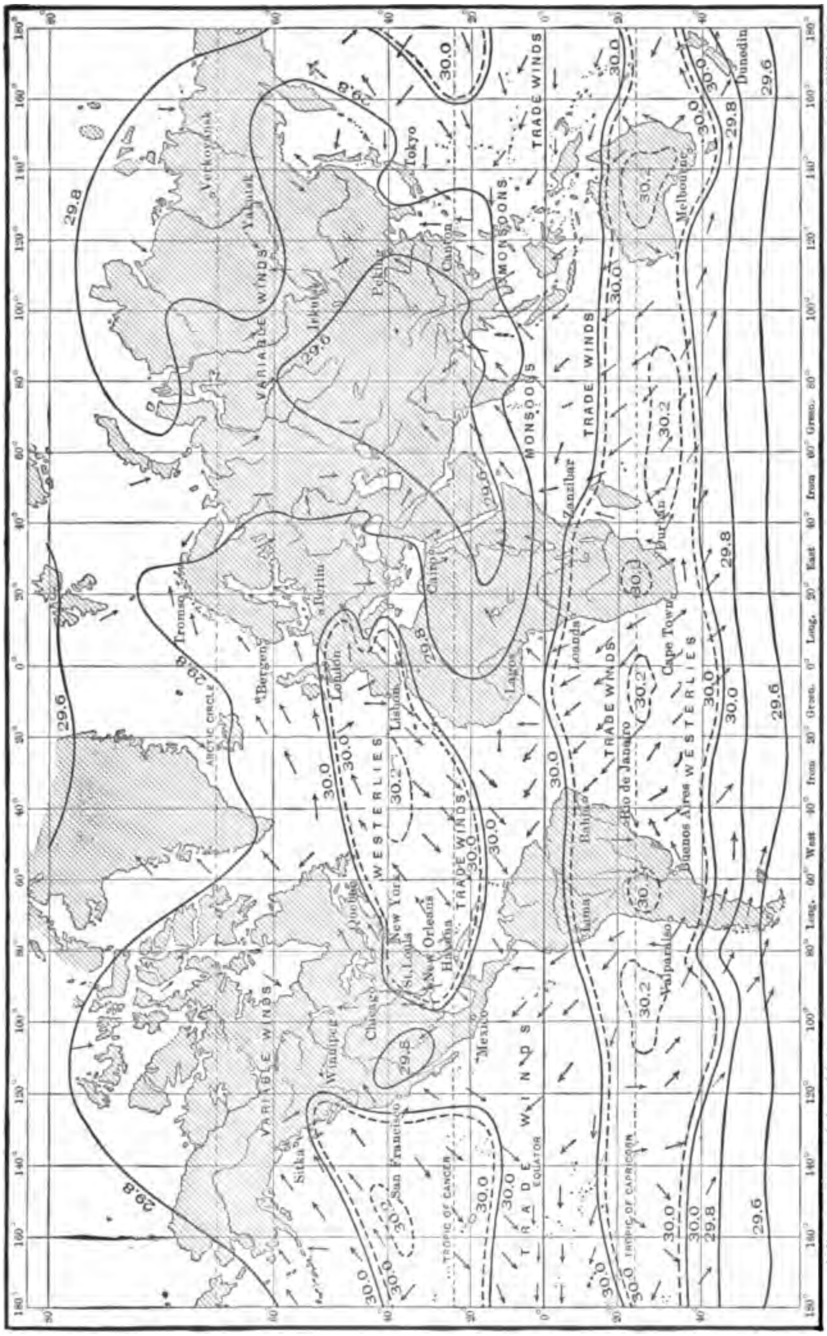
The growth of the continental areas of high or low pressure does not entirely wipe out the pressure belts that have been described for a simplified earth, but it greatly modifies them. Look at Figs. 73 and 74, which show the distribution of atmospheric pressure in January and July. The dotted lines indicate high pressure and the solid lines low, with intermediate regions between them. In the January map notice how the northern sub-tropical belt of high pressure expands over the cold continents, while the southern belt is broken by the continents which are warm in the southern summer. In the July map notice how the northern high-pressure belt is broken by the low-pressure areas over the warm continents, while in the cool southern hemisphere the belt is continuous.

(3) *How Winds Blow in Respect to Continents.*—The importance of the changing areas of high and low pressure over continents and oceans lies in their effect on the winds. Since winds blow from areas of high pressure toward those of low, they tend to blow outward from the continents in winter and inward in summer. In Figs. 73 and 74 the arrows show how the winds blow during January and July. Of




—— indicates pressures below 30 inches

FIG. 73.—Pressure and Winds in January.




— indicates pressures below 30 inches

FIG. 74.—Pressure and Winds in July.

course the direction may change from day to day, but the average direction is what is here shown. Compare the two maps. In January the majority of the wind arrows point away from the high pressure areas of the interior of the northern continents. In July the arrows point inward toward the areas of low pressure in the northern continents. Thus in winter the cold dry air of the continental interior blows outward while in summer the moist and relatively cool air of the oceans blows inward. These outflowing winter winds and inflowing summer winds are strongest in Asia because of its great size and its location in a latitude where the contrast between summer and winter is extreme. They are weak in Africa in spite of the size, for that continent lies largely within the tropics.

**Winds Cause Ocean Currents.**—The movement of the winds causes a corresponding movement of the ocean waters. The currents thus formed carry ships out of their courses when the sky is cloudy and the true position cannot be determined. During and after the Great War they spread explosive mines far and wide to the great danger of shipping. Since the trades are the steadiest winds, they cause the strongest movements. On either side of the equator the trade winds blow the surface water westward, causing what are known as the Equatorial currents. If there were no continents these would combine so that one broad continuous current would pass completely around the world. The continents, however, deflect the currents either northward or southward. In Fig. 75 notice that Cape Saint Roque in South America divides the southern half of the Atlantic Equatorial current into two parts. One goes southward as the Brazil current, while the other joins the northern equatorial current and swings around northward into the Gulf of Mexico.

Where the equatorial current comes out from tne Gulf of Mexico between Florida and Cuba it begins to be known as the Gulf Stream. It is the strongest ocean current that we know of, the only one that moves like a great river. In the Straits of Florida it has a depth of 2000 to 3000 feet, a width of about 40 miles in the narrowest part, and a velocity of nearly five miles an hour. As it comes out into the main Atlantic, however, it quickly loses its river-like quality and spreads into a broad shallow sheet which moves more and more slowly until its rate is only half a mile an hour. Although it keeps away from the immediate coast of the United States, its influence can be felt as far north as Cape Cod. Because of its presence the water on the south side of that cape is distinctly warmer than on the north, as everyone knows who has bathed in both places. When vessels sail from New York to Europe the passengers can easily detect the time

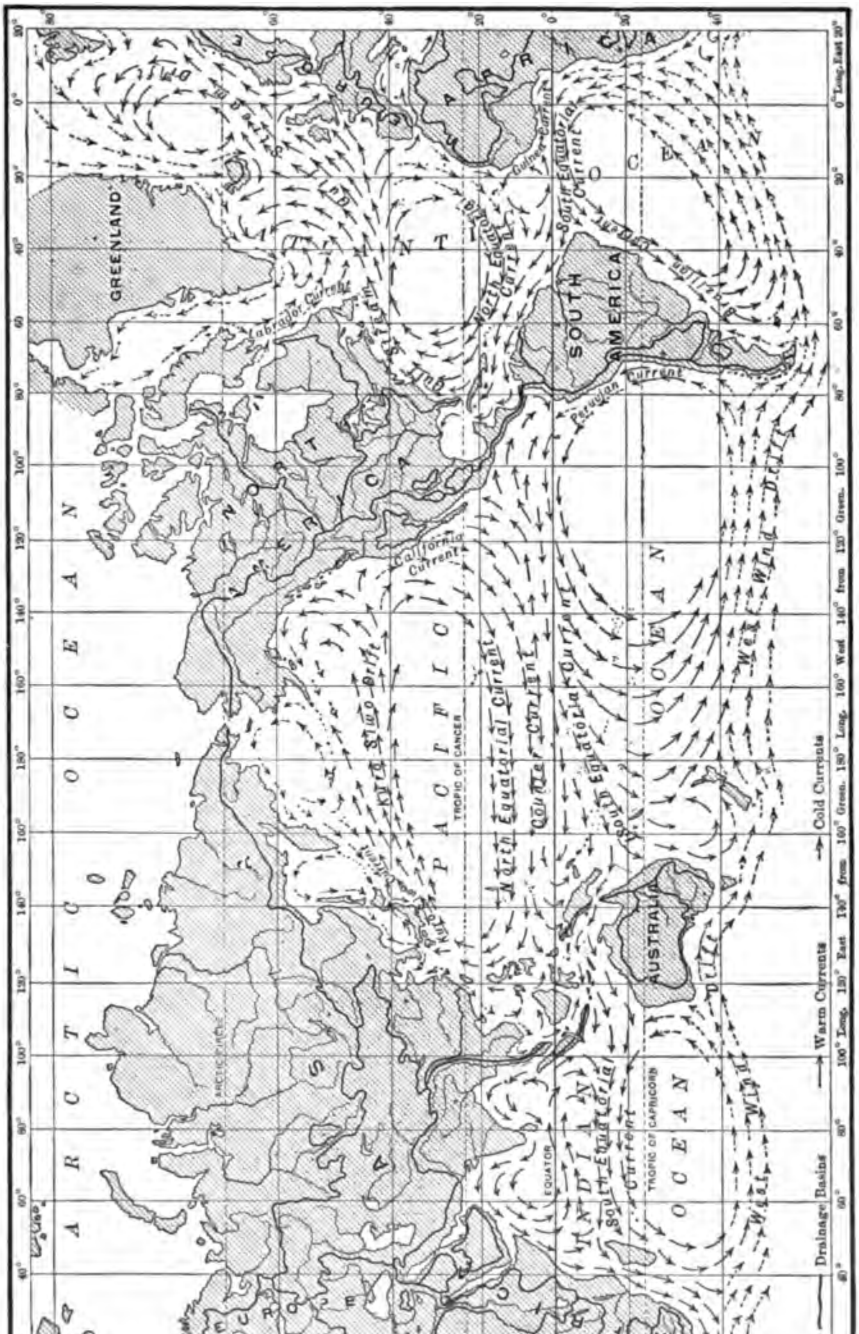



FIG. 75.—Ocean Currents.

when the vessel enters the stream, for the air becomes warmer, the water changes color, and jelly-fish and other forms of life become more abundant.

**How the Atlantic Drift Modifies the Climate of Europe.**—As the Gulf Stream is driven eastward by the prevailing westerlies it spreads out to a breadth of hundreds of miles and becomes the Atlantic "Drift." On the eastern side of the Atlantic part turns south and finally rejoins the equatorial current, while part passes northeastward to the Arctic Ocean past Norway. In the North Atlantic the Drift spreads over the ocean's surface so widely that the winds blowing from the Atlantic Ocean to Europe are warmed, for they absorb some of the heat brought by the current from equatorial regions. Hence the winds blowing from the Atlantic Ocean to Europe are warmer than those blowing from the Pacific to our own continent. This is one reason why the most progressive and populous parts of Europe are about 10°, or 700 miles, farther north than the corresponding parts of North America. It must be remembered, however, that the westerly winds from the North Atlantic would give western Europe a decidedly warmer climate than Labrador even though there were no warm ocean current in the Atlantic.

**The Effect of the Cold Labrador Current.**—Since the Gulf Drift pours part of its waters into the Arctic Ocean, a return current is caused. This cold Arctic current creeps along the eastern coast of Greenland to Labrador and thence to New England. The Labrador Current, as it is called, is of considerable influence in causing the east winds of New England to be cool and raw. Its presence explains why sea-bathing is so much less common at the summer resorts of Maine than on the south shore of Cape Cod, for example.

It also explains the fogs in which the fishermen on the Grand Banks of Newfoundland are sometimes lost and perish. When south winds reach the Labrador Current they are cooled so much that their moisture condenses. This causes frequent fogs not only on the Grand Banks of Newfoundland, but along the coasts of Maine and Nova Scotia. The dangers of the Grand Banks are increased by the icebergs which the Labrador Current brings southward from Davis Strait. Not only are the icebergs dangerous in themselves, but their low temperature increases the fog. Fig. 76 is the official sailing chart of the North Atlantic for August. Notice how many foggy days occur near the Grand Banks. The dangers there are so great that since the *Titanic* was sunk by hitting an iceberg in 1912, the great North Atlantic trade route has been lengthened a little to carry it south of the Banks.

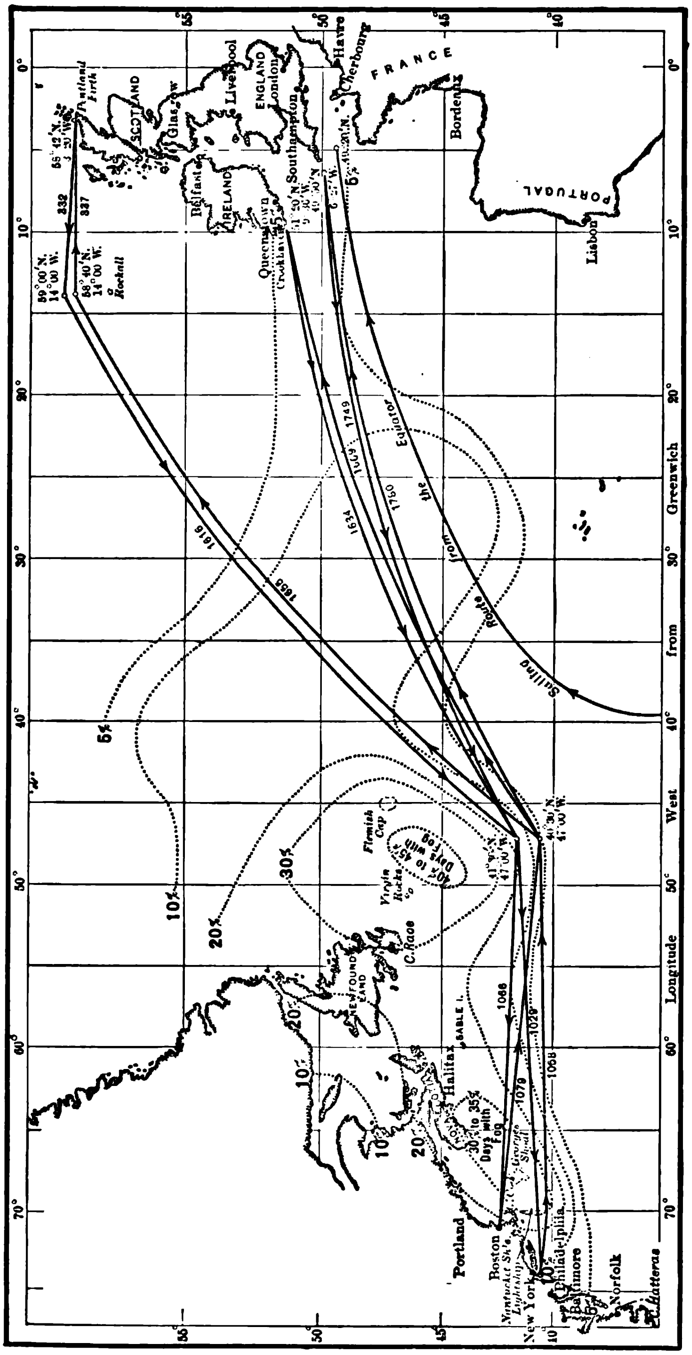



FIG. 76.—North Atlantic Sailing Chart for August. Fog.

The dotted lines show the percentage of days on which fog was observed in August from 1901 to 1906 inclusive.

**The Oceanic Whirls.**—Each of the other oceans, like the Atlantic, has a series of currents which are kept circling around by the prevailing winds. The equatorial part of the Pacific whirl, as it may be called, is deflected northward like that of the Atlantic, but not to so great an extent. Nevertheless, the equatorial waters flowing northward along the west coast of Asia warm the winds sufficiently to make the east side of Japan distinctly warmer than the northwest side, just as the south of Cape Cod is warmer than the north. Even in Alaska the effect of the warming of the water in distant equatorial regions can be felt in the fact that on the south coast the harbors are free from ice in winter.

In the southern hemisphere the whirls of the ocean currents go in

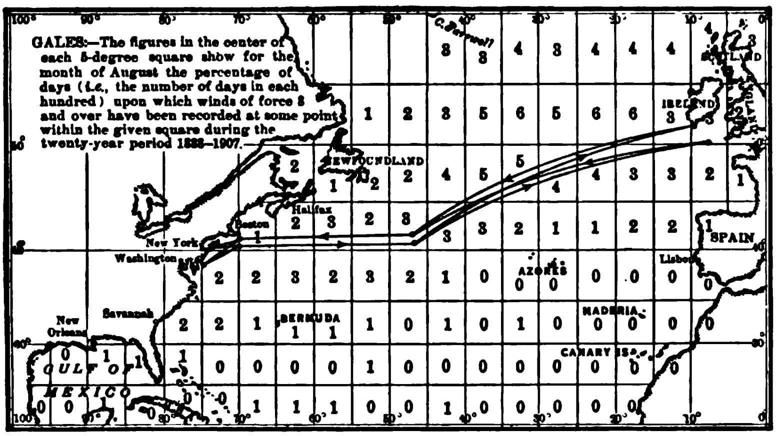



FIG. 77.—North Atlantic Sailing Chart for August. Gales.

the opposite direction from those of the northern hemisphere, since the winds, as we have seen, are deflected to the right in the north and the left in the south. Beyond the southern limit of the whirls an almost unbroken current flows eastward encircling Antarctica. It adds its effect to that of the "roaring forties," as the westerlies are called, in making navigation difficult. Captains of sailing vessels who have to navigate in this region often prefer to go two or three thousand miles extra and travel around the world with the winds and currents rather than to take a shorter course against them.

In the Indian Ocean there are currents like those of the larger oceans. In that region, however, the monsoon winds blow in opposite directions in different seasons, and the currents are correspondingly reversed.

(4) *Why Continental Interiors Have a Good Supply of Summer Rain.* —The movement of the air, as we have already seen, determines how much rain a given place shall receive. In summer when the continents form warm areas of low pressure and inblowing winds, much moisture is brought inland from the oceans. As the moisture-laden air approaches the center of low pressure it gradually rises and finally produces clouds and rain. Look at Figs. 78 and 79 and see how heavy the rainfall is during the summer when inblowing winds prevail.

Because continental interiors receive more rain in summer than at any other season, central Kansas, for example, gets 16 inches of rain in the six months from April to September and only 4 during the other six months. If the Kansas rainfall were evenly distributed throughout the year it would not be enough for agriculture. Luckily the continental low pressure causes the winds to blow toward the interior more strongly in summer than at any other season, and hence as far west as central Kansas the crops are usually well watered. In winter, on the other hand, the low temperature, high pressure, and outblowing winds cause the interiors of the continents to be very dry. Thus though the Dakotas are much colder than New York State in winter, they have far less snow. This is an advantage in some ways, for it permits cattle to pasture all winter, while in the spring the ground is not covered with a layer of snow which would delay the melting of the frost and so prevent early plowing and planting.

**How the Great Seasonal Contrasts of Asia Cause Monsoons.**— The most extreme effect of a continent upon winds and rainfall is seen in Asia. Because of the great size of Asia the extreme difference of temperature between summer and winter may amount to 175° in Siberia north of the Arctic Circle, and to 100° even in southern Persia and western India. The differences between the low pressure of summer and the high pressure of winter are correspondingly extreme. The variations of pressure naturally give rise to strong inblowing winds in summer and outblowing winds in winter. These are best developed in India and are called monsoons. In Figs. 73 and 74 notice that in January the winds in the southern half of Asia all blow more or less from the north. Since they come from the dry interior there is practically no winter rain in large parts of India and China. In spring when Asia grows hot and the high pressure of the interior gives place to low, the outblowing winds weaken and are replaced by irregular winds and calms. Then the air begins to move in from the ocean, and soon strong south or southwest winds are established. In the July map the arrows point in almost the opposite direction from those of January, and the winds of southern Asia all blow inward.

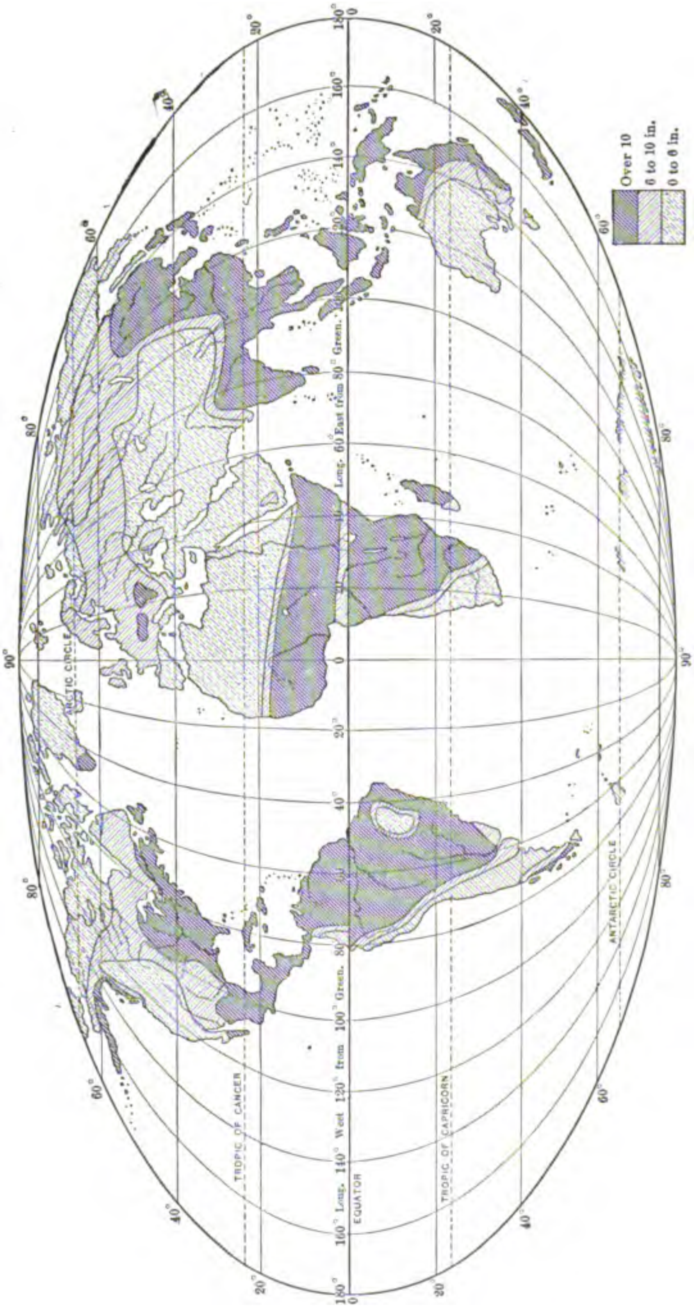



**FIG. 78.—Summer Rainfall. June to August North of Equator—December to February South of Equator.**
Adapted from *Supan.*

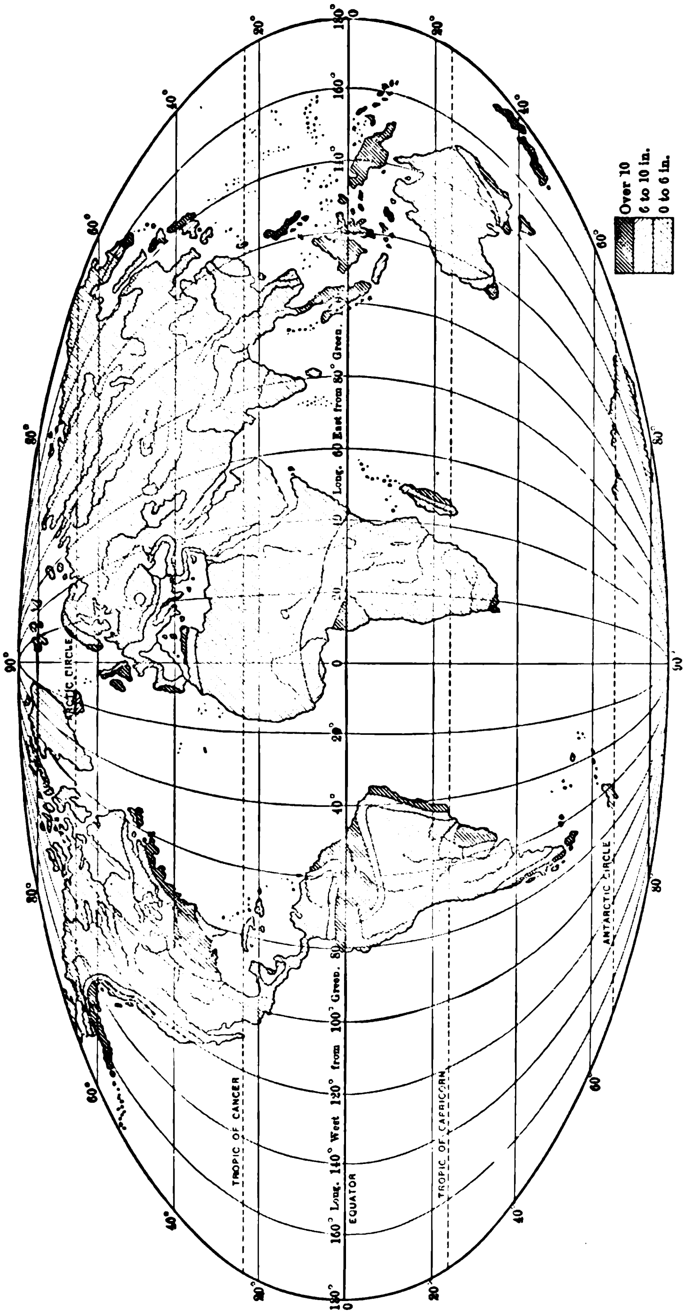



FIG. 79.—Winter Rainfall. December to February North of Equator—June to August South of Equator.

Adapted from *Supan*.

In India the alternation between the northeast monsoon in winter and the southwest monsoon in summer is remarkably regular. The people count upon this regularity so much that formerly when crude sailing vessels were the chief carriers of commerce, native boats from India used to sail to Zanzibar and the African coast each winter with the wind at their backs. Then they spent several months in trading or in idleness waiting for the southwest monsoon to be well established, and finally with the wind blowing toward India they merrily came back with the wind as favorable as on the outward voyage. Even now the natives of the coral islands west of India depend on the monsoons to take them to the mainland and back again. Their sailing boats are so primitive that they cannot make headway against a wind.

**How the Southwest Monsoons Bring Prosperity and Health.**—The most important effect of the monsoons is the rain. In winter only the southern tip of India gets much rain, for that is the only part of the country where the northeast trades blow from the sea to the land. Elsewhere drought prevails month after month and the people long for the summer monsoon. Before it comes the air is burning hot, the ground is parched, and almost nothing will grow. Then the southwest wind begins to blow, the clouds gather, the sky is full of lightning, the thunder crashes, rain falls, the air is cooled, and except in the Indus desert the land is ready for the seed. The people welcome the rains with feasting and rejoicing, for their timely coming usually gives promise of good crops. Moreover, the monsoon rains restore the health of the sick, check epidemics, and bring the most healthful part of the year.

## B. The Effect of Relief

(1) *How Relief Influences Temperature.*—The effect of relief upon the four climatic elements is more easily seen than is the effect of land and sea. Everyone knows that the temperature changes from the base of a mountain to its top. At the base the air may be so warm that the lower slopes are shrouded in tree ferns, graceful palms, twining creepers, and other tropical growths. Higher up the vegetation consists of the broad-leaved trees of the temperate zone. At the top the air is so cold that wastes of naked rock lie close to perpetual snow like that which shrouds the Andes even at the equator.

In tropical lands the temperature becomes more and more favorable to human activity up to a height of about 5000 or even 10,000 feet. Only at such altitudes does the air gain something of the stimulating quality which is so beneficial to health and energy in temperate lands. This is shown in the location of the capitals of the South American republics. Most of them are at altitudes of five to ten thousand feet, that of Mexico City, for example, being over 7000. Even Brazil has decided at some time to remove the capital from beautiful Rio de Janeiro to the interior on the Brazilian plateau. Similarly the summer resorts, recreation centers, and sanatoriums for white people in India are "hill stations" at high altitudes. Simla, among the Himalayas, 7500 feet above the sea, is becoming more and more fully the summer capital of the country. In the Philippines the hill station of Baguio is gradually assuming a similar importance. Without it many American officials and their families would have to leave the islands in order to recover their health.

In high latitudes, on the contrary, the highlands are usually too cold to support many people. In Norway, for example, the central highland is inhabited only by a few Laps.

(2) *Relief and Atmospheric Pressure.*—The effect of relief upon atmospheric pressure is important chiefly in relation to rainfall. As winds blow up a slope the air expands because of a decrease of pressure. Thus it grows cool and gives up rain.

(3) *How Relief Changes the Course of the Winds.*—One of the most important ways in which relief influences climate is through movements of the air. This is because highlands and mountains often change the direction of currents of air, and prevent certain winds from blowing in protected places. For instance, the maritime Alps and the northern Apennines shield the Riviera from the cold north winds. Hence this region on the Mediterranean coast north of the Gulf of Genoa rarely experiences frost even in January, while at Portland, Maine, in the same latitude, the ground is sometimes covered with snow for five solid months. The Swiss and Italian Alps in similar fashion protect the Italian Lake region. Lemons and olives grow there in the latitude of Buffalo or even St. Paul and Minneapolis. The mild winters and beautiful scenery of both the Riviera and the Lake region attract pleasure seekers and invalids from all over Europe. The presence of a great number of people with plenty of money and nothing to do has caused Monte Carlo, in the little principality of Monaco, to become the most famous gambling resort in the world. All these results are due largely to the fact that the Alps by shutting off the winds from the north, prevent cold waves like those which in our own country sweep across the plains and sometimes kill the orange trees even as far south as Florida.

The Himalayas in the same way cause northern India to be warmer than the parts of China in the same latitude. For instance, Delhi, the capital of India on the Jumna, lies in about the same latitude as Hankow, the commercial center of China on the Yangtse, but its January temperature averages 58° while that of Hankow is 39°.

**How Relief Permits Orange Growing in Northern California.**—The effect of relief upon movements of the air and thus upon temperature can be seen not only in great contrasts like that between India and China, but in small contrasts between places only a few miles apart. For instance, in California at the western base of the Sierra Nevadas in a latitude as far north as Philadelphia, there are many small valleys where oranges ripen, although in other valleys close at hand they will not ripen at all. In fact the oranges ripen earlier in some of these northern valleys than in the region around Los Angeles, 400 miles farther south. There are several reasons for this, but all are connected with the relief. (1) The valleys are so located that they face the southwest and thus receive abundant warm sunshine. (2) They are protected from cold winter winds from the interior by the high Sierras immediately to the east. (3) When air grows cool at night it contracts and therefore becomes comparatively heavy. Hence in these valleys instead of remaining and becoming so cool that frost occurs, the air drains away because of the relief. Its place is taken by air which is warmed by descending from above. Where the slopes are favorable there may be no frost, although ice forms not far away in the hollows where the cold air comes to rest. Wherever there is danger of frost wise farmers take advantage of air drainage if their farms are on slopes. They plant their peach and apple orchards, for example, on the warmest slopes where late spring frosts will not nip the blossoms.

The effect of relief upon movements of the air and thus upon temperature is so common that most people have noticed it. At night, for instance, one feels chilly in a hollow, and then is surprised that after going one or two hundred feet up hill the temperature becomes so warm that one feels quite comfortable.

**How Relief Influences Rainfall.**—Aside from cyclonic storms and the great equatorial belt of low pressure, the relief of the lands is the chief cause of rainfall. When a wind reaches a mountainous region the slopes force it to rise. As we have seen in the equatorial belt of low pressure and elsewhere, rising air expands, cools, and loses part of its capacity to hold moisture. Hence clouds form, and rain or snow falls. The process is illustrated in Fig. 69. A good example is seen in the western United States. The shaded part of Fig. 80 shows the altitude of the land from the Pacific Ocean eastward to central Nevada. Where the westerly winds laden with water from the Pacific Ocean strike the low hills at San Francisco the rainfall increases from 18.5 inches to about 23 because the air rises and hence grows cool. Beyond the hills the rainfall decreases a little, but at the foot of the Sierras, where the air once more ascends, it increases rapidly to more than 50 inches. Beyond the mountains part of the air descends down the eastern slope. The descent compresses and warms it, so that its capacity for moisture increases and it sucks up moisture instead of giving it out. Hence at the eastern base of the Sierras there would be no rainfall were it not for occasional cyclonic storms which raise the air to high levels. Thus Reno gets 6 inches of rain and Wadsworth a little over 4.

Regions like Nevada, lying to the leeward of the mountains and thus sheltered from rain-bearing winds, are said to be in the "rain-shadow." Places in a rain-shadow get little rain, just as places in an ordinary shadow get little sunlight. The rain-shadow often causes

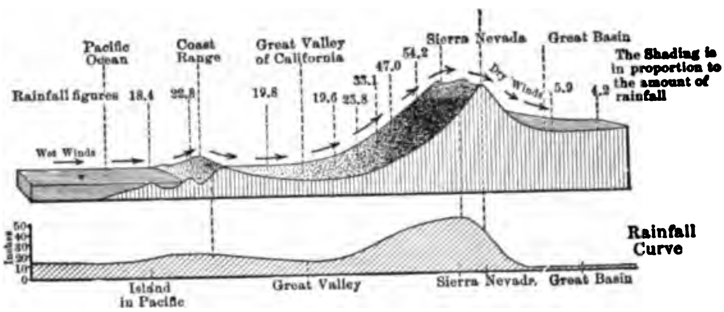



Fig. 80.—Effect of Altitude on Rainfall.

deserts where scraggly little bushes at wide intervals replace the splendid forests which lie at the same altitude on the windward side.

**The Wonderful Effect of the Himalayas on Rainfall.**—The Himalayas furnish the most remarkable example of the effect of mountains on rain. The southerly monsoon winds from the Bay of Bengal bring an abundant supply of water which they deposit as they rise over the lower slopes of the mountains. At a place called Cherrapunji, 4000 feet above the sea and not far north of Calcutta, the average rainfall each year is 466 inches. Compare this with the part of the United States east of the Mississippi where the average is only a little over 40 inches. In 1861 the enormous amount of 918 inches, or 76½ feet, actually fell at Cherrapunji. More than a third of this, or 372 inches, fell in July alone, and 42½ inches in one day. Think of it. As much rain in one day as most Americans see in a year. The heavy rains wash all the soil from the slopes and leave only naked rock, practically bare of vegetation. Yet in the flat places there is a perfect tangle of trees and vines, and plants grow as much in a

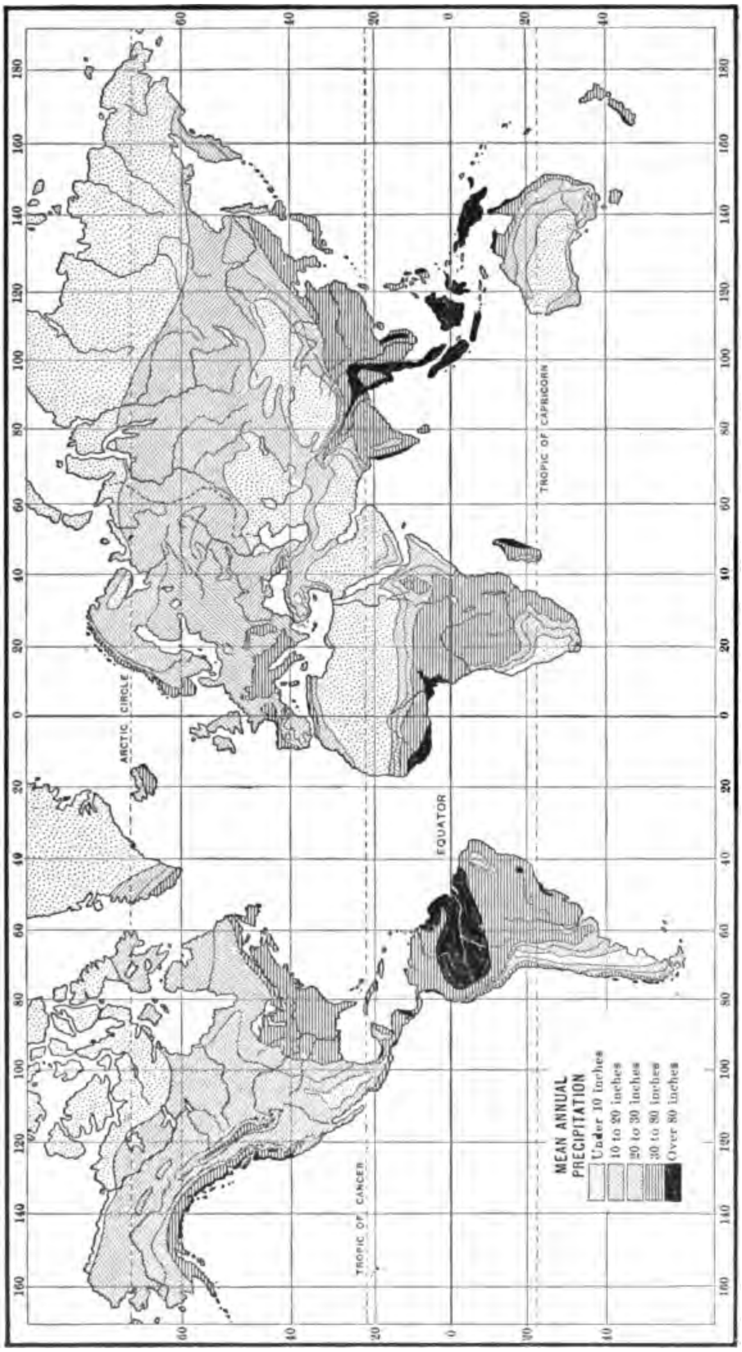



FIG. 81.—Annual Rainfall.

month as they do with us in a year, for even during the rainy period there is some sunshine almost every day.

At higher altitudes on the same side of the Himalayas the rainfall greatly diminishes. The air has lost so much moisture that it cannot give up much. Hence here, as on the windward slope of every mountain, the rainfall increases only up to a certain level after which it decreases. Beyond the Himalayas the air has been so robbed of moisture that vast regions in central Asia are deserts. They lie in the world's greatest rain-shadow.

### Questions, Exercises, and Problems

1. From Figs. 71 and 72 (showing average temperature in January and July) find out the difference of temperature between summer and winter at latitude 40° N. in (*a*) the central United States, (*b*) your home, (*c*) Kansas City, (*d*) Bermuda Islands, (*e*) Irkutsk. In which place do you find the greatest contrast? The least? Write out an explanation, and illustrate it from other parts of the maps.

2. *How Climate Influences the Density of Population.*—Climate largely determines the number of people in a given region. It does this chiefly by controlling the food supply. Where the climate is too cold, too dry, or too wet for food-producing plants the population is generally scanty. The only important exceptions are regions where mining, manufacturing, commerce, or other special reasons cause people to bring food from a distance. In order to understand how climate through its effect on vegetation influences the density of population compare Figs. 71 and 72 with Fig. 38 and then also compare Fig. 81 with Fig. 37.

(*a*) In your note book make a list of regions where sparse population results from low temperature as in northern Canada; from aridity, as in Arabia; from heavy rainfall combined with tropical heat, as in the Amazon Valley. Arrange your lists under the following headings:

Regions of Sparse Population
resulting from

**1. Low Temperature. 2. Aridity. 3. Heavy Rainfall and Tropical Heat.**

(*b*) Make a statement as to the relative sizes of the three kinds of regions with scanty population for the world as a whole. (*c*) What exceptions do you find to the statement that "arid regions contain a sparse population?" (*d*) How do you explain these exceptions? (*e*) What exceptions do you find to the statement that "heavy rainfall combined with tropical heat causes a sparse population?" (*f*) How do you explain these?

3. (*a*) Next make lists of the regions where the population has a density of 100 or more per square mile. Arrange under headings as in 2*a*. After studying the regions in each list add as a part of each heading the conditions of rainfall and temperature that apply in general to the regions listed in the columns.

(*b*) Write out a statement as to the kind of temperature and rainfall most favorable to a dense population.

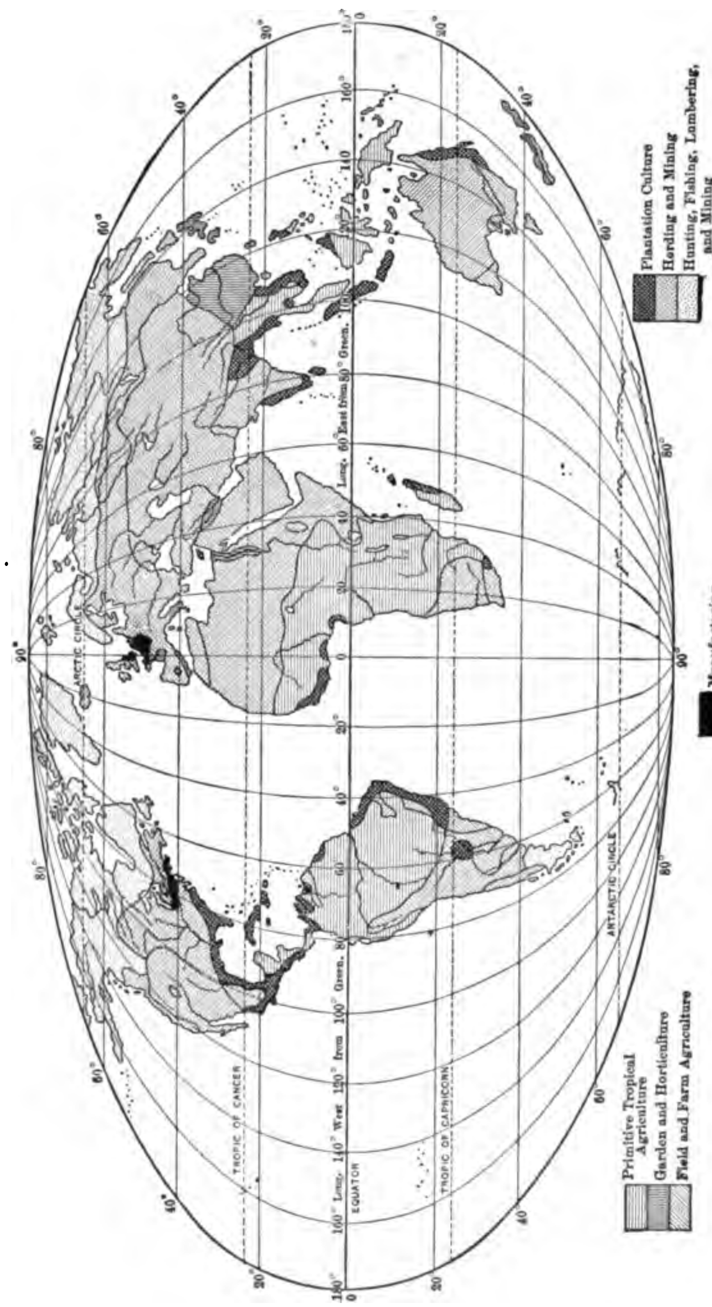



FIG. 82.—Modes of Life.
Adapted from *Bartholomew*.

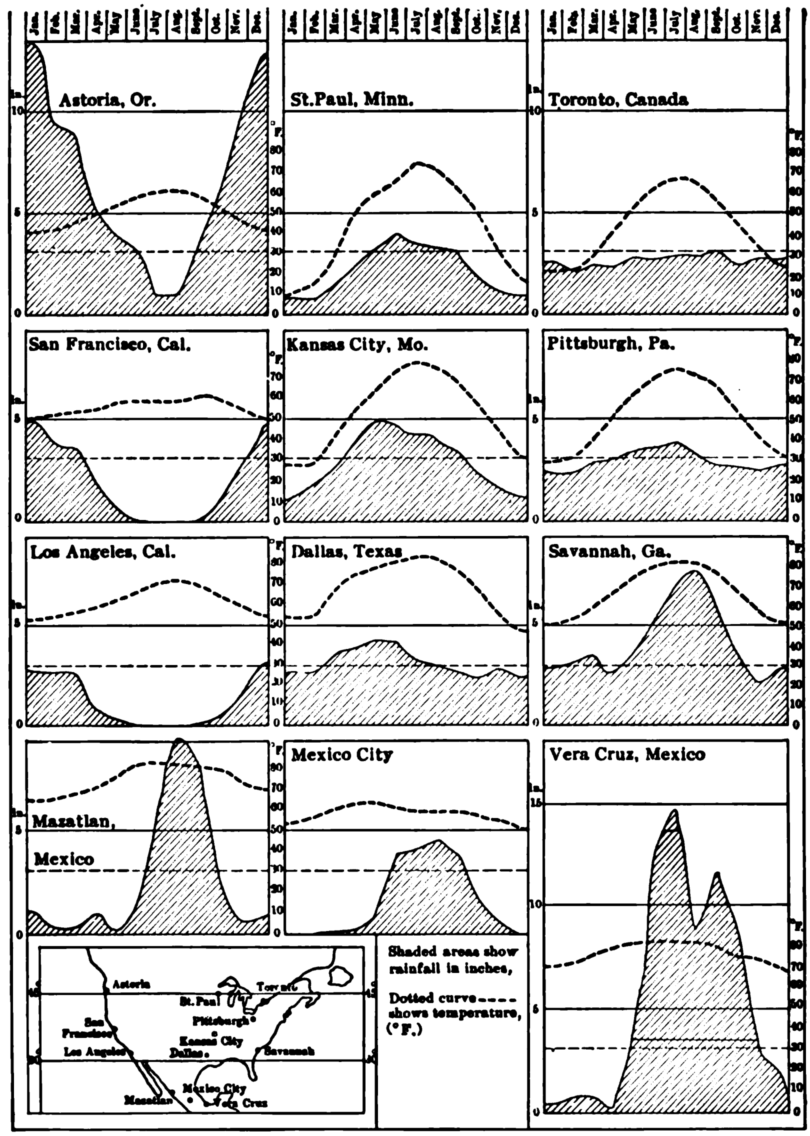



FIG. 83.—Average Monthly Temperature and Rainfall of Typical Places in North America.

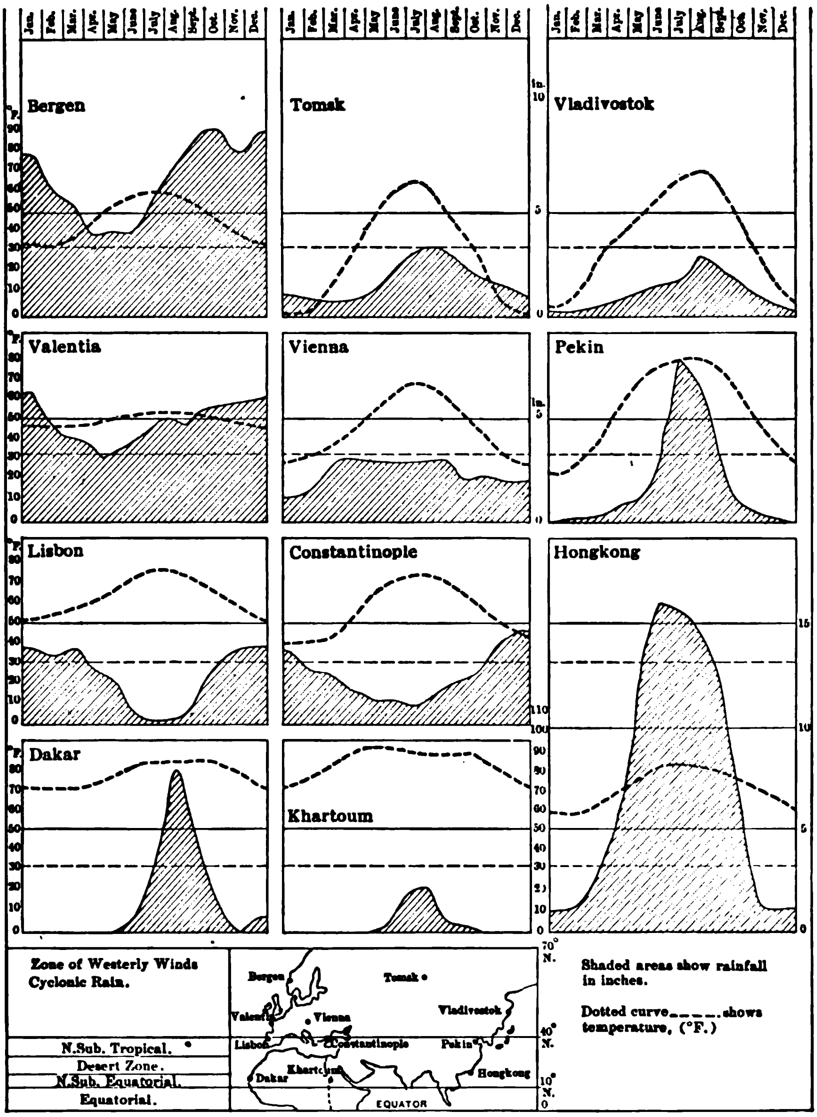



FIG. 84.—Average Monthly Temperature and Rainfall of Typical Places in the Old World.

4. Why is it that in Ireland the January temperature scarcely falls below 40° and in July the average is only 59° in the north and 62° in the south, while in Kamchatcka, in the same latitudes as Ireland, winter temperatures of 40° below zero are common, and in summer 64° is experienced.

5. Fig. 82 shows the main mode of life in various parts of the world. From a comparison of this map with Figs. 71, 72, 78, and 79, make a table having the following headings:

| A | B | C | D |
|---|---|---|---|
| Mode of Life. | Regions where mode prevails. | Temperature conditions (1) Winter, (2) Summer. | Rainfall conditions (1) Winter, (2) Summer. |

On the basis of this table, what do you infer as to the effect of climate on man's mode of life?

6. From the climatic maps in this book and from relief maps in an atlas, determine the type of equipment needed for a camping trip in or near the following places during the months of May, June, and July: (*a*) Spitzbergen; (*b*) the Ganges Delta; (*c*) Bagdad; (*d*) the center of southern New Zealand; (*e*) Para; (*f*) Phoenix, Ariz.; (*g*) Tomsk; (*h*) Hong Kong. Decide for each place the season when travel would be the most pleasant, easy and interesting, and give your reasons. From Fig. 82 and from other sources, decide what sort of accommodations for travellers you would find in the smaller centers of population.

7. A. Figs. 83 and 84 illustrate the conditions of temperature and rainfall in typical parts of North America and Eurasia, together with North Africa. Select diagrams which furnish typical illustrations of as many as possible of the following climatic types: (1) cyclonic storms; (2) monsoons; (3) continental interiors in zone of westerlies; (4) subtropical regions; (5) trade winds; (6) tropical interiors.

B. For each diagram make a table showing the approximate temperature and rainfall for each month. Explain how the diagrams differ from what would be found in the same latitude on a simplified globe such as is described in Chapter X.

C. Among the diagrams of Figs. 83 and 84, pick out four in which the effect of relief is evident. Explain.

8. A. In Figs. 83 and 84 classify the diagrams according to the following:

I. The mode of life as shown in Fig. 82.

II. The density of population as shown in Fig. 38.

B. Explain the relation between Figs. 83 and 84 on the one hand and Figs. 38 and 82 on the other.

## CHAPTER XII

## CLIMATE AND HUMAN ENERGY

**How Climate Affects Man Directly.**—Man's health and energy depend on climate and weather more than on any other single factor. The well-known contrast between the energetic people of the temperate zone and the lazy inhabitants of the tropics is due to climate. It is impossible for a people to advance rapidly in civilization when handicapped by an enervating tropical climate, and even the climate of intermediate regions like Persia, tends strongly to keep people backward.

The best way to understand how climate influences health and energy is to consider how the weather causes our own condition to vary from day to day and season to season. Although some people are more affected than others, everyone is influenced by temperature, humidity, wind, sunshine, barometric pressure, and perhaps other factors such as atmospheric electricity and the chemical composition of the air. On days when all these factors are favorable, people feel strong and hopeful; their bodies are capable of unusual exertion, and their minds are alert and accurate. If all the factors are unfavorable, people feel inefficient and dull; their physical weaknesses are exaggerated; it is hard to concentrate the mind; the day's work drags slowly; and people go to bed at night with a tired feeling of not having accomplished much. Hence in variable climates like that of the United States people's physical and mental energy keep changing from day to day and season to season. Sometimes one feels almost as inert as if he lived within the tropics, but soon a change comes and one again feels the health and energy which make it possible to work hard and think clearly.

**How People's Health and Energy are Measured.**—There are many ways of measuring the variations in the health and energy of a community from season to season. People's energy can be measured by studying what they accomplish in cases where they do the same thing day after day as among piece workers in factories. Again, a good measure of the energy of individuals is found in the testing apparatus used in gymnasiums. Or the health of children, for instance, can be measured by recording their rate of growth in height and weight. The health of the whole community can be measured by the number of deaths from disease. Or again the health and energy of the mind can be measured by finding out the difference from week to week in the work done by school children, bank clerks, or other people whose occupations demand brain work. All these ways of measurement, as well as many others, lead to the same conclusion. In a variable climate such as that of the United States people's health and energy go through a regular series of changes each year.

**The Way in Which People's Physical Energy Varies from Season to Season.**—The variations in people's strength from month to month are so important and teach so much about the distribution of health and energy throughout the world that we may well study them closely. Let us consider first how physical strength varies during the course of the year in the great section extending from southern New England and New York westward to the Rocky Mountains. October is usually the best month. At that time people feel like working hard; they get up in the morning full of energy, and go at their work quickly and without hesitation; they walk briskly to business or work; and play with equal vigor. Headaches, colds, indigestion, and other minor illnesses are fewer than at other seasons; there are also fewer serious illnesses, so that the doctors have less than usual to do, and the number of deaths is less than at any other time of year.

Then as cold weather comes on, the workers accomplish less, ill health becomes more and more common, the physicians are kept busy, and deaths increase. By January or February the general efficiency and health may have dropped 20 or 30 per cent. In a cold winter these bad conditions may last through March, but ordinarily there is an improvement as soon as the air begins to become warmer. The improvement continues through the spring until in May or early June the conditions of health and energy are almost as good as in October. Then with the arrival of hot weather an unfavorable change begins. By the middle of July people's health and energy are often no better than in January and may be worse. The diseases are not quite the same as in the winter, since stomach troubles, for instance, are more common than colds. Moreover, the feeling of laziness that comes over people in hot weather is not quite the same as the sort of suffocating stupid feeling that one has in winter. Yet the effect on work and health, and the result in low efficiency and many deaths are the same.

**How the Effect of the Seasons Varies with Latitudes.**—If we study the people of different latitudes we find that the periods of greatest and least energy occur at different times. In northern Maine or Minnesota, and still more in Canada, there is only one unfavorable period, the winter. People are at their best from July to September; then their health and efficiency decline steadily as the cold winter comes on, and in January and February reach a lower level than during the same months in New York, Chicago, or St. Louis, for example. Farther south, as we have just seen, there are four periods, two of good health in spring and fall, and two of bad health in summer and winter, but the contrast between the good and bad is not so great as in latitude a little higher or lower. In still lower latitudes there are once more only two periods, but in such warm regions the long summer is the unfavorable time, while the short winter is favorable. In central Florida, for example, the long warm summer shows a pronounced decline in health lasting about six months, while the short winter is much the best part of the year. The loss of health and strength due to continued warm weather becomes more pronounced the farther one goes toward the equator.

In the other continents similar conditions prevail. In Europe, in the latitude of Central France and Southern Germany, the seasonal variations of health and strength are much the same as in Boston, New York, Cleveland, and Detroit. That is, people are most healthy and strong in October and early November and again in May and early June, while they are weakest and most subject to disease in January, February, and early March, and again in July or August. There, as here, great variations occur from year to year, according to whether the weather is unusually hot or cold, rainy or dry, variable or monotonous. Farther north, for example, in Scotland, Scandinavia, and Finland, the summer is the best time of the whole year and the winter the worst. To the south, on the contrary, in Italy, Spain and Greece, the harmful effect of the winter decreases and that of summer increases, until finally on the south side of the Mediterranean the winter is much the best time of the whole year, while the long summer greatly diminishes people's efficiency and increases disease and deaths.

**How the Periods of Mental and Physical Activity Differ.**—In general people's mental activity varies from season to season in the same way as physical activity, but there is an interesting difference in one respect. In the latitude of New York, for example, people do the best brain work about the end of November or beginning of December, that is, a month or six weeks after their physical strength is greatest. In the spring, on the contrary, the best mental work is done in March, a month or two before the physical strength reaches its maximum. This means that people's minds are most stimulated in weather somewhat cooler than that which most stimulates their bodies.

**The Optimum Temperature.**—Three conditions of climate are of special importance in their influence on health and energy: (1) temperature; (2) humidity; and (3) variability. For each of these there is a certain most favorable or ideal condition which is called the *optimum*. Every species of plant and animal has an optimum temperature at which it thrives most vigorously, and man is no exception. The optimum may vary a little from individual to individual, but not much. It is more likely to vary from one type of activity to another. For physical health, among the white race, the best temperature is an average of not far from 64° F. for day and night together. In other words, people's health and strength are greatest when the thermometer drops to about 56° to 60° at night and rises to somewhere between 68 and 72° during the middle of the day. For mental activity the optimum temperature appears to be a good deal lower than for physical, being probably about 40°. As a rule, people's minds are most alert and inventive, people do their best thinking and planning and have the best judgment when the thermometer falls about to freezing at night and rises to perhaps 45° or 50° by day.

All human progress depends on activity of both mind and body; an active engineer, for example, is needed to plan a system of water works, an active day laborer to dig the ditches. Hence the best climates appear to be those with an average temperature of not far from 40° during the winter and of about 64° during the summer, but other conditions, such as variability, humidity, and rainfall may alter this. Southeastern England comes nearer to this ideal condition than any other part of the world.

**The Optimum Humidity.**—When the temperature averages about 64° and is therefore close to the optimum for health, the best condition of moisture seems to be a *relative humidity* of about 80 per cent for day and night together. This means that the air contains about 80 per cent as much moisture as it is capable of holding at that particular temperature. When the air grows cool at night, its capacity for moisture becomes less. Hence the water vapor that it contains increases *relatively* when compared with what it is capable of containing, and at length becomes 100 per cent at a temperature of 58°. Then dew begins to form, since the air must give up some of the moisture. By day, on the other hand, when the thermometer rises to 70° the air contains only about 65 per cent as much moisture as it might if it were saturated. When the relative humidity at noon, however, falls much below 50 per cent, the delicate mucous membrances of the nose and throat begin to suffer, the skin is likely to be too dry, people tend to become nervous, and the general conditions of health decline. It must be remembered, however, that the outdoor life which is possible in a dry climate makes up for much of the harm due to dryness. If people were wise they would have as much outdoor life and outdoor air in moist climates as in dry.

In warm weather, such as we have in summer, high humidity coupled with high temperature is very harmful, as is shown by the extreme death-rate in Japan during August and September, when the hot, humid summer produces its full effect. On the other hand, extreme dryness is also harmful in summer. Some of the worst colds, especially those of a catarrhal nature, come from extreme dryness in hot weather. Oddly enough the effect of hot and cold weather is in some respects the same, for both increase nervousness and make the mucuous membranes sensitive, thus giving bacteria a chance to grow.

**How to Remedy Indoor Dryness in Winter.**—In winter such desert-like dryness is very common inside our houses and is one of the great reasons why our work falls off and disease and death increase in the community. By heating our houses we successfully overcome the effect of low temperature, but at the same time we make the air so dry that it is very harmful. In spite of the common idea to the contrary, a damp winter month with an average temperature of 30°, for example, is more healthful than a dry one of the same temperature provided the dampness is not too monotonous. Hence every wise householder takes pains to see that there are large water pans in the furnace and that they are fitted with wicks or other devices for giving a large surface for evaporation. Or if steam or hot water is used for heating, he puts on the radiators some device such as pans of water with cloths suspended in them so that they draw out the water and cause enough to be evaporated to raise the relative humidity in the house to at least 50 per cent and preferably 60 per cent or 70 per cent, if this does not cause wet walls, instead of 30 per cent or less, as is now the case in cold weather. When this is done, the temperature can, and must, be kept between 64° and 68°, where it belongs, for moist air feels warmer than dry air at the same temperature.

**The Optimum Variability.**—A climate may be ideal in temperature and in humidity, and yet be by no means the best kind. This is because all living creatures seem to need change. If animals are fed absolutely the same food day after day they do not thrive nearly so well as if their food is varied. So, too, if plants are kept at the optimum temperature day after day, they will not grow so well as those which enjoy first a warmer and than a lower temperature. Man is also extremely sensitive in this respect. In general a rise of temperature harms him and a drop stimulates him, but a combination of frequent changes in both directions does him much more good than uniformity. In New York City, for example, a drop in temperature causes an increase in people's activity both in summer and winter and a corresponding drop in the death-rate.

**Why a Drop in Temperature is Beneficial.**—It is easy enough to understand how a drop of temperature is beneficial in summer, for then it causes an approach to the optimum. In winter, however, the drop takes the temperature away from the optimum. How then can a cold wave be helpful? It seems to act in two ways: (1) When people are out in the air while the temperature is falling it acts like a cold bath. Unless the change is too great it increases the rapidity of the circulation causing a healthy glow. (2) When people are within doors a drop of temperature in winter is stimulating because it causes the air inside the house to vary in temperature. The furnace fails to preserve that uniform temperature which so many people wrongly suppose to be desirable. Thus the rooms become first a little cool and then grow warm, giving variations which are beneficial to health.

**Why Cold Spells are Harmful.**—While a cold snap is beneficial, a cold spell is harmful for three reasons: (1) The air in the house maintains a nearly stationary temperature. (2) It becomes excessively dry. (3) People keep their houses too warm. This is because the extreme dryness of the air makes them feel chilly, for it causes rapid evaporation from the skin. Even a moving door causes a perceptible and chilly draft. Hence the furnaces are pushed to the limit, and people who feel comfortable at 65° in the fall now want a temperature of 72° to 75°. These three conditions make people feel stupid, nervous, and cross; many catch cold or suffer from headaches; others become sick; and the community suffers more than the usual number of deaths.

**Why Cyclonic Storms are So Helpful.**—Changes in other respects as well as in temperature are highly desirable. For instance, steady sunshine is not nearly so good as a period of sunshine and then one of clouds and rain. But too much cloudiness also leads to ill health and to inefficiency. What is needed is frequent changes of all sorts, not too extreme, but quite frequent. For this reason the countries in the regions of cyclonic storms are particularly fortunate. They enjoy changes of weather every few days.

Take a week in early April as an example. On the first day there is frost in the morning, but a warm sun in a brilliant blue sky raises the thermometer to above 50° at noon, and people begin to talk of their gardens. That night there is no hint of frost even in the coldest valleys. The next day a dry wind blows from the south; the temperature reaches 70° by noon; the robins chirp on the lawn; the buds on the lilacs swell visibly; and people wish they had put on their summer clothes. The third day the wind has shifted to the southeast, and the air though still warm is soft with moisture and feels much pleasanter than the day before. All day clouds come and go, the beautiful billowy clouds of spring. Several times little showers fall, but after a few minutes the sun comes out again. People say to one another, "April showers bring May flowers." In the afternoon a warm rain begins, but by morning the wind has shifted to the east and the air is cooler. Then toward evening a violent gale blows from the north, the thermometer drops 5° an hour, and the ground is covered with snow to a depth of an inch or two. That night the clouds disappear before a strong northwest wind, the stars shine like twinkling points in a sky of crystal, and it seems as if winter had returned. Yet the next morning the air is bracing rather than cold; the lilac buds are larger then ever, and when the warm sun melts the snow the grass appears surprisingly green. And so the weather comes back to where it started. Within five days the temperature has varied from almost arctic to almost tropical; the humidity has ranged from that of deserts to that of mid ocean; and the wind has changed from the zephyrs of the horse latitudes to the gales of the roaring forties. Such are the habits of the weather in some of the regions of cyclonic storms.

**Where is the Ideal Climate for Man's Work?**—We are now ready to ask ourselves what parts of the world have the best climate. Remember that the best climate has three chief characteristics: (1) It must have cool but not cold winters, as a mental stimulus, and warm, but not hot summers as a physical stimulus. (2) It must have a fairly high humidity except in warm weather. (3) It must have frequent changes of weather. No region on earth fully satisfies all three of these requirements. Southeastern England and the neighboring parts of continental Europe come nearest to the ideal. Their chief limitation is that changes of weather are not quite frequent and strong enough, and there are sometimes long periods of monotonous dampness. Farther east, in Germany, the conditions are much like those of the southern New England States and New York except that changes are not quite so numerous nor so extreme. The northern United States east of the Rocky Mountains is almost ideal in its number of storms and its humidity, but its winters are too cold and its summers often too hot. The western coast of the United States, on the contrary, is almost ideal as to temperature and has a favorable degree of humidity most of the time. It does not have enough storms, however, and hence is too monotonous.

Japan is another country that approaches the ideal climate because of its favorable temperature, many storms, and frequent changes. The chief difficulty in the southern part where most of the people live is that the summers are too warm and especially too moist.

In the southern hemisphere, New Zealand has probably the best climate, for there are no extremes of temperature and storms are fairly abundant. The southeastern corner of Australia also has a fairly stimulating climate, as have parts of Argentina and Chile, but in these three regions cyclonic storms are not very numerous and hence there is not sufficient variability.

**A Map of Climatic Energy.**—Fig. 85 shows how human energy would be distributed if it depended wholly on climate. Of course it actually depends also on many other conditions such as inheritance, food, shelter, and training, but for the present purpose we may omit these. The heavily shaded parts show where the climate has the

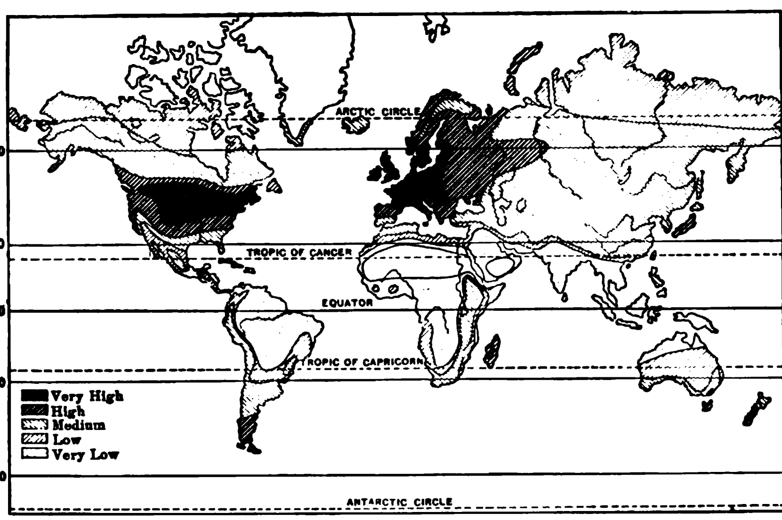



FIG. 85.—Map of Climatic Energy.

greatest effect in giving people good health and making them energetic. Notice the two main dark areas, one in the United States and the other in western Europe. The area in the United States is interrupted somewhat in the desert parts of the country because of the long summer heat and drought. The European area projects eastward into Russia on the borders of Siberia, but gradually disappears, for many of the cyclonic storms die out, while extremes of temperature and of dryness prevail in the center of the continent. Only on the far eastern side of Asia in Japan does another area of high energy appear. South of the three good areas in the United States, Europe, and Japan, the conditions of health and energy steadily decline, and reach their worst near the equator. Then they improve, but nowhere in the southern hemisphere do they rise as high as in the north. Thus three main facts appear: (1) the north temperate zone of cyclonic storms is much the best part of the world; (2) the interiors of continents in the zone of cyclonic storms are usually not so good as the coastal regions; and (3) the southern hemisphere has good areas corresponding to those of the northern, but not equal to them.

**How Climate Influences Character.**—Energy has an important relation to character. Where the climate is stimulating it is easy for people to be industrious. When they get up in the morning they often feel so much like work that they are eager to begin before the regular time. Such people are likely to be inventive or to make improvements and carry out reforms. They do not necessarily have more ideas than others, but their energy makes it possible to put the

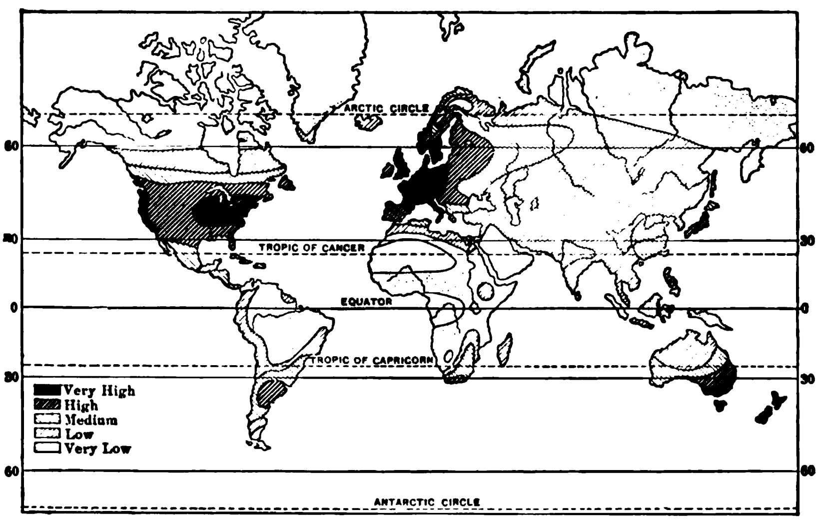



Fig. 86.—Map of Civilization.

ideas into practice. In an invigorating climate it is also easier to be honest and sober and self-controlled than in a more enervating one. It is much easier to speak the truth or to control one's temper when one feels strong than when one feels weak.

People who live in good climates are apt to look down upon those who live in poorer climates. That is a great mistake. The effect of climate is like that of food. We do not look down upon people who are weak because they have been unable to get good food. People such as missionaries and wise colonial administrators who have lived long in tropical countries have learned that while religion, education, and good government greatly benefit the natives, nothing can overcome the effect of the climate. Will power, industry, and self-reliance like that of people in more bracing climates can be gained only by a process so slow that it will take centuries.

Because a person happens to be born in an unfavorable climate he is not necessarily incapable or less high minded than those born where the climate is more stimulating. In fact when a man who lives in an unfavorable climate such as that of Venezuela distinguishes himself he deserves greater credit than does an equally distinguished man from a more favored region such as Louisiana, and much more than one who lives in a highly stimulating region like Ohio. The Venezuelan has to draw upon his own will power for much of his energy, while the man from Ohio receives his from a stimulating climate. Thus our Southern States deserve more credit for their achievements than do the Northern States.

**How Climate Explains the Distribution of Civilization.**—Climatic energy has much to do with the advance of civilization. Fig. 86 shows the distribution of civilization according to the opinion of about fifty eminent men from different countries in North America, Europe, and Asia. The heavily shaded regions contain people who stand especially high in the scale of civilization. Compare this map with Fig. 85, which shows climatic energy. On both maps the black areas together with the heavily shaded areas which surround them cover approximately the same regions. They embrace most of the United States and southern Canada, most of Europe, Japan, southeastern Australia, and a portion of South America. The agreement between regions of stimulating climate and high civilization means that the health and energy imparted by such a climate are among the conditions necessary for progress. Other conditions such as the influence of men of genius, good government, an ennobling religion, and strong institutions are also necessary just as good water, good food, and proper shelter as well as good air are necessary to health.

**A Climatic Comparison: The Bahamas and Canada.**—To understand the relation of climate and civilization let us compare the province of Ontario, where the climate is one of the best in the world, and the Bahama Islands, which have a warm, monotonous, tropical climate. The original white settlers in both places were of the same stock. They were English colonists, many of whom left the United States at the time of the Revolution because of their loyalty to England. To-day the descendants of the Loyalists in Canada are one of the strongest elements in causing that country to be conspicuously well governed and progressive. In the Bahamas the descendants of similar Loyalists probably show a larger proportion of inefficient, incompetent individuals than can be found in almost any other Anglo-Saxon community. Among the Canadians practically everyone has a fairly good education. Among the Bahamans a large number have never been to school, and many who learned to read and write in their childhood have forgotten these arts because they do not practice them.

The main cause of these differences is the climate, although other factors such as the presence of negroes in the Bahamas play an important part. As the Bahamans themselves say, "This climate is very healthful and pleasant as everyone knows. That is why people come from the North to spend part of the winter at beautiful Nassau. The only trouble is that it doesn't make one feel like work. In winter it's all right, although even then we can't fly around the way you Americans do. In summer we go to bed tired and we get up more tired, and our summer lasts from April to October. It's all very well for you Americans to think we're lazy, but try living here a year or two yourselves, and you'll be as lazy as we are." A Bahaman girl who returned to the Islands for a visit after studying nursing in New York was asked whether she enjoyed life more in the United States or at home. "How can one help enjoying it more there?" she answered. "There one *feels* like doing things. Here one never *feels* like doing anything." The whole matter is well summed up by a local proverb which says that you cannot tell whether a Bahaman woman is pretty until she goes away and has a chance to grow plump and get some color in her cheeks. Some of the more thoughtful Bahaman parents send their children to the United States or England, not only for education, but to live permanently. They feel that the Bahamas are not a white man's country.

The chief trouble in the Bahamas seems to be the monotony of the climate. There is almost no malaria or hookworm disease, two of the chief scourges of more tropical countries. The temperature is not excessive and the hottest days are by no means so warm as in Kansas City, for example. There are few cyclonic storms, however, and therefore few changes, and nothing to stimulate activity. Hence although people may have good ideas and may intend to carry them out, it is very hard to make an effort. When the Bahaman gets up in the morning he feels a sort of dullness. The regular routine of daily life can be carried on without much difficulty, but when a new kind of work is to be done, he says, "Wait till to-morrow." Hence civilization will continue to make little progress until the Bahamans are taught how to overcome their climatic handicap.

The Canadian cousins of the Bahamans, on the contrary, make great progress in civilization. They are full of that superabundant energy which makes people want to get out and do something. We all know the feeling. It sometimes leads us to do foolish and even harmful things, but on the whole it keeps us profitably active and alert. This activity and alertness are one chief reason why Canada is an important member of the Family of Nations.

The Bahaman should not be blamed for his laziness or the Ontarian praised for his achievements. It is the climate that deserves blame in one case and praise in the other.

**Climate only One Factor in Causing Civilization.**—It must not be forgotten that a stimulating climate is *only one* of the conditions which promote a country's civilization. The world may be likened to a canvas upon which several artists are painting a picture of civilization. One artist, called climate, paints a set of colors which may be harmonious in one place and unpleasantly lurid or faded in others. Race adds other tints, sometimes good and sometimes bad. Religion paints still other colors, while institutions, government, and education each add their tints. If all the colors are good in any part of the world, that region will have a high civilization. The United States and western Europe are particularly fortunate in being the two areas where the colors form favorable combinations on the largest scale.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. A. Keep an outdoor weather record and an indoor record for a period of two or three months during the winter (and, if possible, again in summer). For the outdoor record use three thermometers: (1) maximum; (2) minimum; (3) wet bulb. The maximum thermometer may also be used as (4) a dry bulb. For the indoor record use a wet and a dry bulb thermometer. Be sure to fan the wet bulb a minute before taking a reading, especially indoors, where the air is still. The indoor thermometer should be hung in some room where people are in the habit of sitting. The indoor record should show the usual conditions and not those when the room is being aired.

Once a day at a regular hour make a record of the following four temperatures outdoors: (1) maximum; (2) minimum; (3) wet bulb; (4) dry bulb. Note the direction and force of the winds according to the following scale:

| Scale Numbers. | Corresponding Wind. | Limits of Hourly Velocity Miles per Hour. |
|---|---|---|
| 0 | Calm | Under 2 |
| 1 | Light breeze | 2–12 |
| 2 | Moderate wind | 13–23 |
| 3 | Strong wind | 24–37 |
| 4 | Gale | 38–55 |
| 5 | Storm | 56–75 |
| 6 | Hurricane | Above 75 |

At the same time make a record of the wet and dry bulbs indoors. Also record the days when you feel particularly energetic or particularly well able to study, and the days when you do not feel energetic and when work drags. Omit, however, the days when you know that your condition is due to some special circumstance, as good news, a late party, or too much or too little exercise.

B. After your record is well started plot on a single sheet the following conditions: (1) outside temperature; (2) change in outside temperature in 24 hours; (3) inside temperature; (4) average temperature of maximum and minimum which is practically the mean for the day; (5) relative humidity of the outside air; (6) relative humidity of the inside air; (7) strength of the wind.

**C.** Pick out from the record the days which seem to you particularly good on the basis of (1) temperature, paying attention to both indoor and outdoor conditions; (2) relative humidity indoors and out; (3) change of temperature; (4) movement of the air. Explain whatever relation you see between your physical and mental conditions and the weather.

## RELATIVE HUMIDITY TABLE

To determine the relative humidity find the reading of the dry bulb thermometer on the left of the table and in the line thus indicated find the proper number in the column having at its head the difference between the dry and wet bulbs. For example; Dry bulb 68°, wet bulb 61°, difference 7°. In the column headed 7 and opposite a temperature of 68° we find 67, which means that the air has the excellent relative humidity of 67 per cent.

DIFFERENCE IN DEGREES BETWEEN WET AND DRY BULB THERMOMETERS

| Reading of Dry Bulb Thermometer. Fahrenheit | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 90 | 79 | 69 | 60 | 50 | 41 | 31 | 22 | 13 | 4 | | | | | | | | | | |
| 33 | 90 | 80 | 71 | 61 | 52 | 42 | 33 | 24 | 16 | 7 | | | | | | | | | | |
| 34 | 90 | 81 | 72 | 62 | 53 | 44 | 35 | 27 | 18 | 9 | 1 | | | | | | | | | |
| 35 | 91 | 82 | 73 | 64 | 55 | 46 | 37 | 29 | 20 | 12 | 4 | | | | | | | | | |
| 36 | 91 | 82 | 73 | 65 | 56 | 48 | 39 | 31 | 23 | 14 | 6 | | | | | | | | | |
| 37 | 91 | 83 | 74 | 66 | 58 | 49 | 41 | 33 | 25 | 17 | 9 | 1 | | | | | | | | |
| 38 | 91 | 83 | 75 | 67 | 59 | 51 | 43 | 35 | 27 | 19 | 12 | 4 | | | | | | | | |
| 39 | 92 | 84 | 76 | 68 | 60 | 52 | 44 | 37 | 29 | 21 | 14 | 7 | | | | | | | | |
| 40 | 92 | 84 | 76 | 68 | 61 | 53 | 46 | 38 | 31 | 23 | 16 | 9 | 2 | | | | | | | |
| 41 | 92 | 84 | 77 | 69 | 62 | 54 | 47 | 40 | 33 | 26 | 18 | 11 | 5 | | | | | | | |
| 42 | 92 | 85 | 77 | 70 | 62 | 55 | 48 | 41 | 34 | 28 | 21 | 14 | 7 | | | | | | | |
| 43 | 92 | 85 | 78 | 70 | 63 | 56 | 49 | 43 | 36 | 29 | 23 | 16 | 9 | 3 | | | | | | |
| 44 | 93 | 85 | 78 | 71 | 64 | 57 | 51 | 44 | 37 | 31 | 24 | 18 | 12 | 5 | | | | | | |
| 45 | 93 | 86 | 79 | 71 | 65 | 58 | 52 | 45 | 39 | 33 | 26 | 20 | 14 | 8 | 2 | | | | | |
| 46 | 93 | 86 | 79 | 72 | 65 | 59 | 53 | 46 | 40 | 34 | 28 | 22 | 16 | 10 | 4 | | | | | |
| 47 | 93 | 86 | 79 | 73 | 66 | 60 | 54 | 47 | 41 | 35 | 29 | 23 | 17 | 12 | 6 | 1 | | | | |
| 48 | 93 | 87 | 80 | 73 | 67 | 60 | 54 | 48 | 42 | 36 | 31 | 25 | 19 | 14 | 8 | 3 | | | | |
| 49 | 93 | 87 | 80 | 74 | 67 | 61 | 55 | 49 | 43 | 37 | 32 | 26 | 21 | 15 | 10 | 5 | | | | |
| 50 | 93 | 87 | 81 | 74 | 68 | 62 | 56 | 50 | 44 | 39 | 33 | 28 | 22 | 17 | 12 | 7 | 2 | | | |
| 51 | 94 | 87 | 81 | 75 | 69 | 63 | 57 | 51 | 45 | 40 | 35 | 29 | 24 | 19 | 14 | 9 | 4 | | | |
| 52 | 94 | 88 | 81 | 75 | 69 | 63 | 58 | 52 | 46 | 41 | 36 | 30 | 25 | 20 | 15 | 10 | 6 | 1 | | |
| 53 | 94 | 88 | 82 | 75 | 70 | 64 | 58 | 53 | 47 | 42 | 37 | 32 | 27 | 22 | 17 | 12 | 7 | 3 | | |
| 54 | 94 | 88 | 82 | 76 | 70 | 65 | 59 | 54 | 48 | 43 | 38 | 33 | 28 | 23 | 18 | 14 | 9 | 5 | | |

RELATIVE HUMIDITY TABLE—*Continued.*

| Reading of Dry Bulb Thermometer. Fahrenheit | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | 94 | 88 | 82 | 76 | 71 | 65 | 60 | 55 | 49 | 44 | 39 | 34 | 29 | 25 | 20 | 15 | 11 | 6 | 1 | |
| 56 | 94 | 88 | 82 | 77 | 71 | 66 | 61 | 55 | 50 | 45 | 40 | 35 | 31 | 26 | 21 | 17 | 12 | 8 | 3 | |
| 57 | 94 | 88 | 83 | 77 | 72 | 66 | 61 | 56 | 51 | 46 | 41 | 36 | 32 | 27 | 23 | 18 | 14 | 10 | 5 | |
| 58 | 94 | 89 | 83 | 77 | 72 | 67 | 62 | 57 | 52 | 4 | 42 | 38 | 33 | 28 | 24 | 20 | 15 | 12 | 7 | 2 |
| 59 | 94 | 89 | 83 | 78 | 73 | 68 | 63 | 58 | 53 | 48 | 43 | 39 | 34 | 30 | 25 | 21 | 17 | 13 | 9 | 4 |
| 60 | 94 | 89 | 84 | 78 | 73 | 68 | 63 | 58 | 53 | 49 | 44 | 40 | 35 | 31 | 27 | 22 | 18 | 14 | 10 | 6 |
| 61 | 94 | 89 | 84 | 79 | 74 | 68 | 64 | 59 | 54 | 50 | 45 | 40 | 36 | 32 | 28 | 24 | 20 | 15 | 12 | 7 |
| 62 | 94 | 89 | 84 | 79 | 74 | 69 | 64 | 60 | 55 | 50 | 46 | 41 | 37 | 33 | 29 | 25 | 21 | 16 | 14 | 9 |
| 63 | 95 | 90 | 84 | 79 | 74 | 70 | 65 | 60 | 56 | 51 | 47 | 42 | 38 | 34 | 30 | 26 | 22 | 17 | 15 | 11 |
| 64 | 95 | 90 | 85 | 79 | 75 | 70 | 66 | 61 | 56 | 52 | 48 | 43 | 39 | 35 | 31 | 27 | 23 | 18 | 16 | 12 |
| 65 | 95 | 90 | 85 | 80 | 75 | 70 | 66 | 62 | 57 | 53 | 48 | 44 | 40 | 36 | 32 | 28 | 25 | 20 | 17 | 13 |
| 66 | 95 | 90 | 85 | 80 | 75 | 71 | 66 | 62 | 58 | 53 | 49 | 45 | 41 | 37 | 33 | 29 | 26 | 21 | 18 | 14 |
| 67 | 95 | 90 | 85 | 80 | 76 | 71 | 67 | 62 | 58 | 54 | 50 | 46 | 42 | 38 | 34 | 30 | 27 | 22 | 19 | 15 |
| 68 | 95 | 90 | 85 | 81 | 76 | 72 | 67 | 63 | 59 | 55 | 51 | 47 | 43 | 39 | 35 | 31 | 28 | 23 | 20 | 16 |
| 69 | 95 | 90 | 86 | 81 | 77 | 72 | 68 | 64 | 59 | 55 | 51 | 47 | 44 | 40 | 36 | 32 | 29 | 24 | 21 | 18 |
| 70 | 95 | 90 | 86 | 81 | 77 | 72 | 68 | 64 | 60 | 56 | 52 | 48 | 44 | 40 | 37 | 33 | 30 | 26 | 23 | 19 |
| 71 | 95 | 90 | 86 | 82 | 77 | 73 | 69 | 64 | 60 | 56 | 53 | 49 | 45 | 41 | 38 | 34 | 31 | 37 | 24 | 20 |
| 72 | 95 | 91 | 86 | 82 | 78 | 73 | 69 | 65 | 61 | 57 | 53 | 49 | 46 | 42 | 39 | 35 | 32 | 28 | 25 | 21 |
| 73 | 95 | 91 | 86 | 82 | 78 | 73 | 69 | 65 | 61 | 58 | 54 | 50 | 46 | 43 | 40 | 36 | 33 | 29 | 26 | 22 |
| 74 | 95 | 91 | 86 | 82 | 78 | 74 | 70 | 66 | 62 | 59 | 54 | 51 | 47 | 44 | 40 | 37 | 34 | 30 | 26 | 23 |
| 75 | 96 | 91 | 87 | 82 | 78 | 74 | 70 | 66 | 63 | 59 | 55 | 51 | 48 | 44 | 41 | 38 | 34 | 31 | 27 | 24 |
| 76 | 96 | 91 | 87 | 83 | 78 | 74 | 70 | 67 | 63 | 59 | 55 | 52 | 48 | 45 | 42 | 38 | 35 | 32 | 28 | 25 |
| 77 | 96 | 91 | 87 | 83 | 79 | 75 | 71 | 67 | 63 | 60 | 56 | 52 | 49 | 46 | 42 | 39 | 36 | 33 | 29 | 26 |
| 78 | 96 | 91 | 87 | 83 | 79 | 75 | 71 | 67 | 64 | 60 | 57 | 53 | 50 | 46 | 43 | 40 | 37 | 34 | 30 | 27 |
| 79 | 96 | 91 | 87 | 83 | 79 | 75 | 71 | 68 | 64 | 60 | 57 | 54 | 50 | 47 | 44 | 41 | 37 | 34 | 31 | 28 |
| 80 | 96 | 91 | 87 | 83 | 79 | 76 | 72 | 68 | 64 | 61 | 57 | 54 | 51 | 47 | 44 | 41 | 38 | 35 | 32 | 29 |
| 82 | 96 | 92 | 88 | 84 | 80 | 76 | 72 | 69 | 65 | 62 | 58 | 55 | 52 | 49 | 46 | 43 | 40 | 36 | 33 | 30 |
| 84 | 96 | 92 | 88 | 84 | 80 | 77 | 73 | 70 | 66 | 63 | 59 | 56 | 53 | 50 | 47 | 44 | 41 | 37 | 34 | 31 |
| 86 | 96 | 92 | 88 | 85 | 81 | 77 | 74 | 70 | 67 | 63 | 60 | 57 | 54 | 51 | 48 | 45 | 42 | 38 | 36 | 32 |
| 88 | 96 | 92 | 88 | 85 | 81 | 78 | 74 | 71 | 67 | 64 | 61 | 58 | 55 | 52 | 49 | 46 | 43 | 40 | 37 | 34 |
| 90 | 96 | 92 | 89 | 85 | 81 | 78 | 75 | 71 | 68 | 65 | 62 | 59 | 56 | 53 | 50 | 47 | 44 | 41 | 39 | 36 |
| 92 | 96 | 92 | 89 | 85 | 82 | 78 | 75 | 72 | 69 | 65 | 62 | 59 | 57 | 54 | 51 | 48 | 45 | 42 | 40 | 37 |
| 94 | 96 | 93 | 89 | 86 | 82 | 79 | 75 | 72 | 69 | 66 | 63 | 60 | 57 | 54 | 52 | 49 | 46 | 43 | 41 | 38 |
| 96 | 96 | 93 | 89 | 86 | 82 | 79 | 76 | 73 | 70 | 67 | 64 | 61 | 58 | 55 | 53 | 50 | 47 | 44 | 42 | 39 |
| 98 | 96 | 93 | 89 | 86 | 83 | 79 | 76 | 73 | 70 | 67 | 64 | 61 | 59 | 56 | 53 | 51 | 48 | 46 | 43 | 40 |
| 100 | 96 | 93 | 90 | 86 | 83 | 80 | 77 | 74 | 71 | 68 | 65 | 62 | 59 | 57 | 54 | 52 | 49 | 47 | 44 | 42 |

2. On an outline map of the world indicate by dots the desert and semi-arid regions having a rainfall of less than 20 inches per year. Trace on this map the isotherms for 70° in July (Fig. 72) and 30° in January (Fig. 71) and shade the undotted lands between these two lines. What does this map indicate as to the extent and location of regions where the climate is highly stimulating both mentally and physically? It must be remembered, of course, that considerable areas on each side of the shaded areas also possess excellent conditions.

3. In Bartholomew's Meteorological Atlas, Huntington's Civilization and Climate, or some other book find a map of the distribution of storms. Compare this with Fig. 86 showing the distribution of civilization and record your conclusions.

4. On an outline map of the world indicate by a solid line the 70° isotherm for summer and by a dotted line the 70° isotherm for winter. Shade the lands between these two lines. How do the size and location of the shaded areas compare in the two hemispheres? What does this indicate as to the variability of climate north and south of the Equator? Which has the advantage? Why? Compare your map with the map of civilization, Fig. 86, and draw conclusions.

5. Look up the following aboriginal people: (*a*) Kaffirs; (*b*) Bantus; (*c*) Maoris; (*d*) Australian Aborigines. Indicate on a map of the world the places where each of them was originally most numerous. What specific climatic influences help to account for the diverse abilities of the four races?

6. Look up the statistics for immigration into the United States for five years, using the reports of the Commissioner of Immigration or the *World Almanac.* On an outline map of the world draw a line in each chief country proportional to the number of immigrants sent by it to the United States. Compare your map with Figs. 85 and 86. What do you conclude as to the civilization of our immigrants and the climate of the countries from which they come?

## PART VII

## *MAN'S RELATION TO VEGETATION AND ANIMALS*

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## CHAPTER XIII

## THE EARTH'S GARMENT OF VEGETATION

**The Importance of Plants and Animals.**—Thus far we have devoted our attention chiefly to the direct responses of man to the five great elements of physical environment. We have passed from location, land forms, water bodies, soil and minerals, and climate directly to man's activities. Only here and there have we touched on the plants and animals which form the second column in the geographic diagram of Fig. 1. Now that we have studied climate, however, we are ready to consider how plants and animals influence man's activities. They exert their influence chiefly through agriculture, the great industry which furnishes most of our food and raw materials.

How important plants and animals are may be judged from the fact that in the United States about 40 per cent of the population depend directly upon agriculture. Someone has well said that previous to 1900 the chief manufactured product of the United States was 5,740,000 farms with an area of 840,000,000 acres. The number of farms is still increasing, although not so rapidly as formerly, because the greater part of the good land has already been occupied. In 1920 the farms of the United States, including buildings, equipment, and animals, as well as the soil where the crops are grown, were worth about one hundred billion dollars. This is more than twice as much as the capital invested in all kinds of manufacturing enterprises in this country. The number of people who live on the farms is also twice as large as the number who depend on manufacturing.

Even in a country like England, where manufacturing is predominant and home production of food does not begin to supply the demand, agriculture employs more people than all the railroads, steamships, and other means of communication, and more than the metal industries which have made British cutlery and other hardware famous all over the world. Elsewhere agriculture is still more important. In Russia three-fourths of the people are peasants, while in India and China the proportion is even larger. Thus plants and animals determine the mode of life and the prosperity of far more than half the world's inhabitants.

**How the Nature of the Vegetation Determines the Character of Agriculture.**—Although the farmer uses both plants and animals, plants are much the more important because animals as well as men depend upon them. The full importance of plants, however, does not appear until we also realize that the differences in agriculture from region to region depend largely on the different kinds of plants which the climate and soil permit. The man who clears the tropical jungle cannot possibly raise the same crops as the one who lives in the far north where a growing season of only three months permits little save barley to be raised. Nor can he plant and reap his crops in the same way, or use the same variety of animals. So, too, the man who lives in the fertile grasslands of the prairie raises corn, wheat, horses, and cows, while the one who inhabits a hot desert oasis raises millet, dates, camels, and goats. What the chestnut and olive are to the Spanish peasant, the bread-fruit tree is to the scantily clad inhabitant of the tropical Marquesas Islands in the South Pacific. Even in the same latitude the parts of Yucatan that favor the growth of sisal give rise to a kind of farming different from that which prevails in the wetter regions where rubber trees and cacao thrive. The Lapp who raises reindeer does so because the vegetation that will grow in his cold northern region will support no other kind of animal, and will not furnish crops that man can eat. In all these cases vegetation is the chief factor in determining how the people get a living.

**The Three Great Types of Vegetation.**—Since plants are the most important factor in the lives of such a vast number of people, we must understand the variations of natural vegetation and the causes of their distribution. The ordinary plants that form the earth's garment of vegetation may be divided into three great groups: (1) trees; (2) bushes, scrub, and woody perennials; and (3) grasses and other herbaceous forms. Without this varied garment of vegetation the lands of the earth would be as barren as the moon with its wastes of desolation. While soil and relief have much to do with the local distribution of these three groups, their general distribution over the world as a whole depends chiefly upon two climatic factors: (*a*) the length of the season warm enough for growth; and (*b*) the proportion of that season during which there is moisture enough to promote growth.

*Trees.*—Although trees are the highest form of vegetable life, they are in many ways more sensitive than bushy or grassy vegetation. They are sensitive to drought, especially when young. Everyone who has traveled from a well-watered region to one that is dry knows how the trees diminish in size and become scrubby, or else become few in number and are limited to places with more than the usual amount of moisture. Trees also need a fairly long growing season. That is why the tree-line on mountains is lower than the upper limit of grasses. On the higher slopes of the mountains, although there is plenty of moisture the warm period when growth is possible is not long enough to enable trees to make their growth and ripen their seeds, although grasses succeed without difficulty. Accordingly trees attain a fine growth and form great forests in regions which have a moderately long warm season during which there is abundant moisture. Such regions may be as varied as the Belgian Congo, Siberia, the eastern United States, and the Andes of southern Chili.

*Bushes and Scrub.*—The plants classified under this head range all the way from scrubby trees to perennials with more or less woody stems which die back in part after each growing season. Such plants are mixed with the trees in most forested regions. Where the conditions of climate or soil become unfavorable to trees, however, bushes crowd them out and become the chief growth. This can be seen near the tree line on the sides of mountains where low temperature prevents the growth of trees sooner than of bushes. It is also seen on the edges of swamps where too much moisture in the soil prevents many kinds of trees from growing, but does not drive out the bushes. Again where the soil becomes thin and hence dry, the trees give place to bushes. The most noteworthy of all regions for bushes, however, are subtropical and desert regions or the parts of the torrid zone where the dry season is particularly long. The mountains of Sicily with their scrubby "dry forests," the sage brush desert of Utah, the bushy desert of Arizona, and the areas of tropical scrub in the dry parts of Colombia are all examples of this type.

The bushy growths of dry regions differ from trees in being able to maintain themselves through protracted droughts provided they have water at occasional intervals. Many of them have drought-resistant leaves. In some, like the laurel and live oak, the leaves are hard and shiny; in others such as the sage, they are soft and furry. Both types have coverings that hinder evaporation and thus protect the plants during the long dry season. Many such plants also bear prickly leaves or spines. These incidentally protect the plants against the ravages of animals, but in most cases they originate through a progressive reduction in the plant's evaporating surface. The plants in which evaporation is restricted have the best chance of survival in the desert.

*By courtesy of the American Forestry Magazine.*

FIG. 87.—An Adirondack Forest.

**Broad-leaved hard wood mixed with some conifers at lower levels; and conifers (red spruce and balsam fir) at the higher, colder elevations. Typical mature mountains, and a glacial lake.**

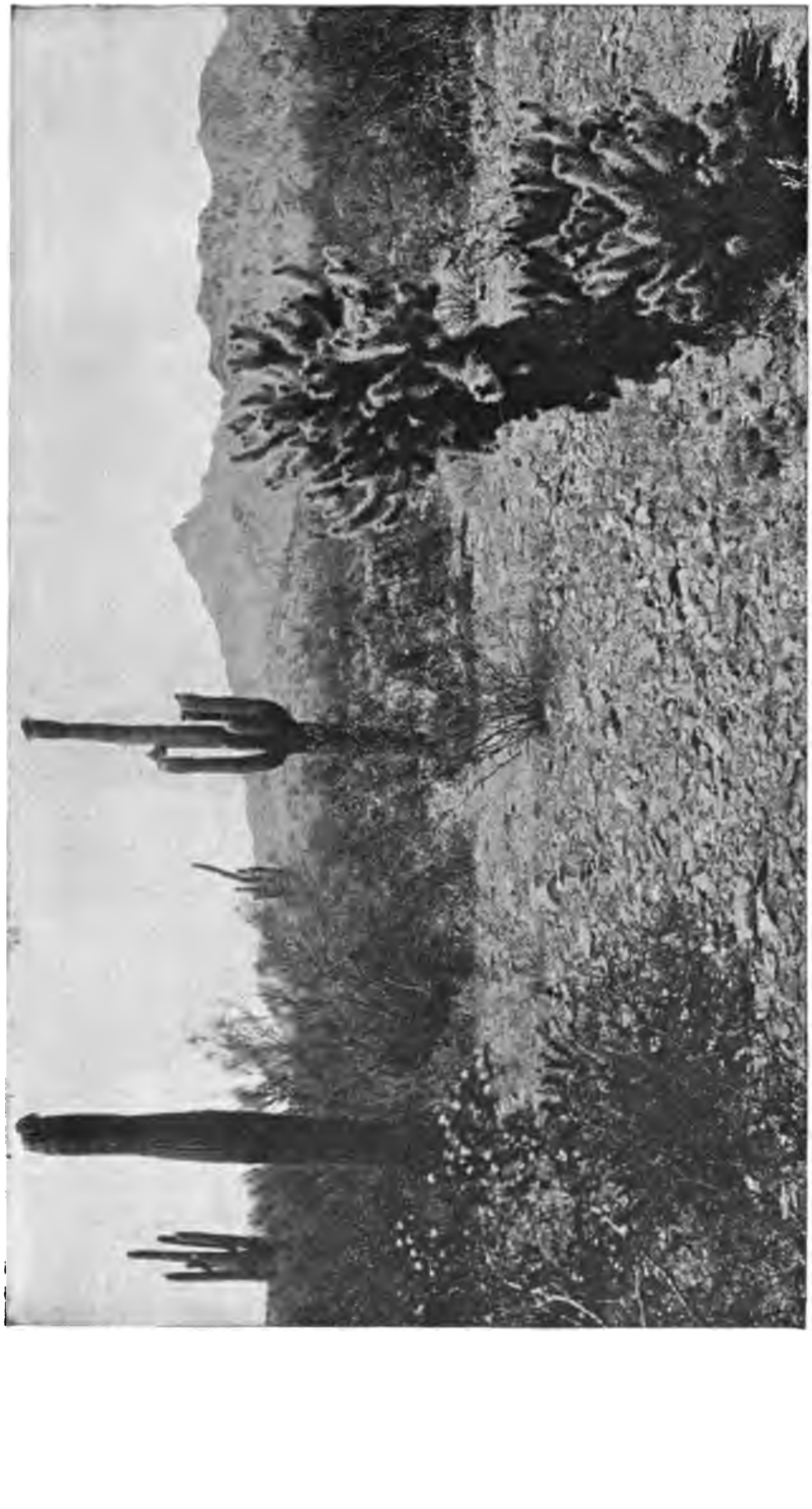


Fig. 88.—Desert Vegetation in Southern Arizona.

Giant cactus or suhuaro in flower in center and on left, extremely prickly cholla cactus on right, mesquite bushes on left near big cacti, and grease wood bush in front of middle suhuaro. Typical desert mountains in background. Compare with Fig. 103.

*Grasses.*—Tne modest grasses grow under a greater variety of circumstances than do either trees or bushes. Many grasses can complete their growth and mature their seeds in a few weeks so that a single shower in the desert may be enough for them. They often grow so rapidly that they can thrive on high mountains where the warm season is too short for trees or bushes. Hence above the tree line there are lofty green pastures or "alps" that furnish food for sheep and cattle in Switzerland, Norway, and elsewhere. Grasses can endure not only aridity, low temperature, and short seasons of growth, but also excessive moisture which would be fatal to trees and bushes. Hence the dripping hills of Ireland, Scotland, and Wales, and the soggy marshes of Holland are clothed with soft. lush grass which makes excellent pasture.

**A Mountain Showing World-wide Types of Vegetation.**—A most interesting illustration of the relation of climate to trees, bushes, and grasses is found on the western slope of the Sierra Nevada in California. At the base the climate is so dry that the traveler finds the plain and the lower foothills clothed with grass which is green only a few weeks. A little higher up, as the rainfall increases, bushy vegetation of many sorts is met, including the wild lilac, the yucca, and the manzanita, with its smooth hornlike stems. The live-oak tree, with its hard, prickly leaves appears, and before one has climbed far he is in the midst of a dry forest, that is, one composed of drought resistant trees many of which are scrubby. At higher altitudes where there is abundant rain the dry forest is replaced by a wet forest of broad-leaved trees like the ordinary oak and sycamore. Then, where the air is colder, the type changes to coniferous forests of pines, giant sequoias, spruces, and firs. Next, where the growing season becomes too short for trees, one struggles through a dense thicket of bushes bent down by six months of snow each year. Finally, when these are left below, the open grassy slopes of the "alps" are reached, for here where the temperature is too low for woody plants the grasses thrive far better than they do in the dry, hot desert far below. Thus within a day's climb one may find illustrations of most of the world's main types of vegetation.

**Distribution of Vegetation on a Simplified Globe.**—The distribution of trees, bushes, and grasses over the earth's surface seems at first sight to be most complicated. It follows definite laws, however, as may be seen from a comparison of the accompanying table with Fig. 89. The table shows how vegetation would be distributed on a simplified globe, such as we have used in discussing climate. The map shows, in a general way, the actual distribution. By comparing the map with the table we can see how the distribution of plants is affected

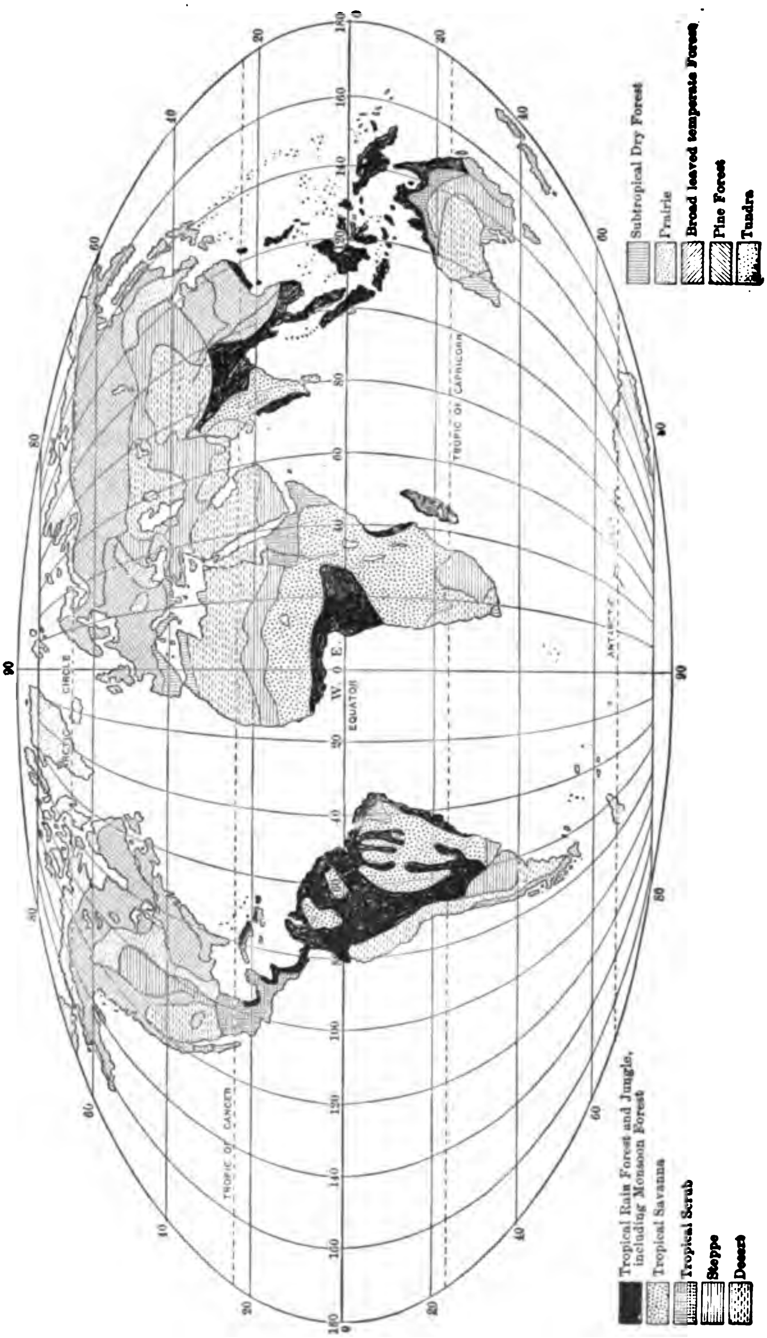



FIG. 89.—Map of Distribution of Vegetation.

FIG. 90.—IDEAL DISTRIBUTION OF VEGETATION AND CIVILIZATION ON A SIMPLIFIED GLOBE

| Type of Vegetation. | Approximate Latitude. | Climate. | Density of Population. | Condition of Civilization. | Examples. | |
|---|---|---|---|---|---|---|
| | | | | | A Foreign. | B United States and its Dependencies. |
| (1) Equatorial rain-forest | 0– 7° | Always hot and moist | Sparse | Very low | Amazon Basin | Panama Zone, South Philippines |
| (2) Tropical jungle | 7–15° | Always hot; long rainy season, short dry season | Dense | Low | Southern India | Porto Rico, Virgin Islands |
| (3) Tropical scrub | 10–20° | Always hot; long dry season | Moderate | Low | Northern edge of Yucatan | |
| (4) Savanna grass-land | 15–25° | Always hot or warm; dry season and wet season | Moderate | Low | Sudan | Small parts of North Philippines |
| (5) Desert | 20–35° | Always dry; warm winter, ho summer | Sparse | Very low to high | Arabia | Nevada |
| (6) Subtropical dry forest | 30–40° | Cool, moist winter, but hot dry summer | Moderate | Medium to very high | Spain | Southern California |
| (7) Prairie | 35–45° | Cool dry winter, hot rainy summer | Dense | High or very high | Hungary | Iowa, Illinois |
| (8) Deciduous forest | 42–55° | Cold snowy winter, hot rainy summer | Dense | Very high | England, France | New York, Pennsylvania |
| (9) Coniferous forest | 55–65° | Long, cold, snowy winter; short, warm, rainy summer | Moderate | High | Northern Sweden | Northern Maine, Northern Wisconsin |
| (10) Tundra | 65–75° | Long, cold, snowy winter; short, cool, rainy summer | Sparse | Very low | Northern coast of Canada | Northern Alaska |
| (11) Polar desert | 75–90° | Always winter | No people | Absent | Northern Greenland | |

not only by the zonal arrangement of temperature and moisture on the earth's surface, but by the relief of the lands, and especially by the presence of moisture. Far larger areas bear sparse vegetation because of aridity than because of low temperature.

(1) *Equatorial Rain Forest.*—Close to the equator a simplified globe would be surrounded by a zone of the densest kind of equatorial rain forest. It is called the *rain forest* because the dry seasons are here so short that the ground never becomes parched, and most of the year there is a superabundance of moisture. As the temperature is always high, vegetation can grow rapidly at all times. The trees rise to great heights and form a somber canopy which shuts out the sunlight. The forest is mostly uninhabited, and the few people who dwell in it are uncivilized savages like those of the Amazon Basin. On the map this kind of forest does not form a continuous equatorial belt, because it is interrupted not only by the oceans but by mountains and plateaus. Nevertheless it covers vast areas in the Amazon and Congo basins and in the East Indies and the Malay Peninsula. Smaller outlying areas of similar forest are found on the rainy east coasts of Central America and Brazil, on the west coast of India and the Malay Peninsula, and at the base of the eastern Himalayas.

(2) *Tropical Jungle.*—Poleward of the tropical regions, approximately in latitudes 7° to 15°, the rainfall on a simplified globe though still abundant, would diminish and the dry season become longer than at the equator. Hence the equatorial rain forest would give place to the kind of forest called tropical jungle. Many of the trees in such a forest are of large size. More, however, are moderate in height and in some of the drier parts bushes become abundant. The chief characteristic of the typical jungle is the way in which vegetation runs riot. The plants crowd upon one another so closely that a person unskilled in the lore of the forest may lose himself in five minutes. This is the part of the world where it is easiest for man to get a living. Hence in the cleared portions, the population is often dense, but the people do not stand high in civilization. In America the jungle regions comprise large areas in Central America and the northern part of South America, together with southeastern Brazil. In Africa there is a good deal of jungle on the borders of the equatorial forest and also in Abyssinia, Madagascar, and along the eastern coast, but owing to the high altitude the proportion of jungle is less than in other tropical regions. In Asia, the best examples of jungle are in southern India, Indo-China, and the drier parts of the East Indies, while northern Australia also has a considerable area.

(3) *Tropical Scrub.*—Although equatorial rain forests and tropical jungle are the two most typical kinds of vegetation in the warmest

parts of the earth, there are also vast areas of scrub and grassland Both of these are more or less mixed with the jungle and with each other by reason of variations in soil, altitude, and relief. On a simplified globe the scrub would form a band on each side of the equator where the jungle diminishes in height and vigor because of the increase in the length of the dry season as one gets farther from the equator. In the scrub regions the bushes are green fully half the year, but lose their leaves during the dry season and look like a second growth in an American woodlot late in the autumn. Occasionally, however, a bare bush covered with great red, white, yellow, or purple flowers makes one realize that he is within the tropics and only 10° to 20° from the equator. In Fig. 89 it is not easy to show the location of areas of tropical scrub with any accuracy because they are apt to be small and scattered. They occur, however, in many parts of southern Mexico and Central America, central and southern Africa, the drier parts of the plateau of India, and the northern portion of Australia. Although civilization is low in such regions, it is often higher than in the jungle regions, as appears in Yucatan and the northern part of the Deccan Plateau in India. This is because disease is less rife than in the insect-infested jungle regions, more work is needed to get a living, and more care must be taken to provide food for the long dry season.

(4) *Savanna.*—As one proceeds away from the equator on a simplified globe, the scrubby brush lands gradually give place to broad grassy areas. Sometimes these are dotted with clumps of trees or bushes, the outposts of the forest and the scrub. In other places they are absolutely treeless except along the rivers. The "pampas" of Argentina and the "Llanos" of Venezuela are some of the best known savannas. In central Africa among the highlands and farther north in the great plains of the Sudan similar grasslands are developed on a vast scale, while in northern India and northern Burma they occur in large patches. The parts of such savannas where trees alternate with grass are almost ideal for big game. The trees furnish shelter, while the grass furnishes food for innumerable animals such as buffaloes, antelope, giraffes, zebras, elephants, and many smaller herbivorous species, and these in turn supply food for lions, tigers, leopards, and other carnivores. For man, however, the savannas are not so good. The grass, to be sure, furnishes food for cattle, although it is apt to be much tougher and less nutritious than the grass of more northern regions. In the long dry season, however, water can be procured only from wells of extreme depth. The sod is so tough that it is difficult to plow. Hence most of the natives of tropical grasslands wander from place to place with their cattle. A good example is the Kaffirs of South Africa, among whom prices are

reckoned in so many cows. Many tropical highlands also have large areas of grasslands, and these are among the best parts of the tropics as may be seen in the plateau around Mexico City.

(5) *Deserts.*—Poleward from the grasslands the desert begins. Usually there is no sharp transition, for the grassland and sometimes the scrub gradually diminish as one passes into regions where the equatorial rain belt has less and less effect. On a simplified globe the deserts would be most pronounced between 25° and 30° from the equator, where the subtropical area of high pressure and the trade winds prevail alternately according to the season. On the actual earth, however, the deserts occupy these latitudes only on the western sides of the continents, while rainy monsoon areas lie on the east. To make up for this, as it were, the deserts extend into much higher latitudes in the interior of the continents, especially in Asia.

Both grasses and bushes are found in the deserts. The plants which support such wandering people as the Arabs consist of grasses and other small herbaceous forms which sprout quickly after the infrequent rains, remain green only a few weeks, and then wither and disappear so quickly that one would never know they had existed. In most deserts, however, there is also a more permanent type of vegetation, consisting of little bushes spaced far apart so that each has a large area where it can spread its roots horizontally and thus get as much water as possible from each infrequent shower. Some types, which grow in hollows, form what may be called an inverted forest, for the roots reach far down to ground water, and are so large that they form as it were an underground forest, far bigger than the small plants that rise above the surface. Throughout most of the desert, however, the water table is so deep that plants are unable to reach it.

Although the total number of plants in a desert is small compared with moister regions, the number of species is large. Not only are there the relatively long-lived bushy types and the temporary grasses and the other herbaceous forms which grow up quickly after rains, but in the moist spots there are the same kinds as in regions of abundant rain, while around the salt lakes there are forms similar to those that grow on the seashore. In addition to this the desert is full of highly specialized plants like the cactus adapted for storing large quantities of water. The cactus can retain water so long that specimens which were pulled up by the roots and hung in a dry place for eight years still retained half as much water as at the beginning. The desert of northwestern Mexico is the home of a curious almost leafless bush somewhat larger than a currant bush. Its stout tapering stems are covered with a glossy bark and look hard and woody. When a twig is cut, however, the knife goes through it easily as if it were made of wax, and drops of sap begin to fall almost in a stream. The bark is waterproof, but wherever it is broken the stored water oozes out rapidly. Because of the necessity of adapting themselves to extreme aridity, many of the genuine desert plants are peculiarly awkward in appearance. Their fat, hairy stems, their spines, and their fuzzy or leathery leaves seem uncouth compared with the graceful vegetation of moister regions.

(6) *Subtropical Dry Forest.*—On the cooler borders of the desert, especially on the western side of the continents, the vegetation in latitudes 30° to 40° or more consists of subtropical dry forest. This is also found on many mountains which rise within the desert itself. It is composed of small, gnarled, hard-leaved trees or bushes which often form open park-like expanses through which it is easy to travel. In some places, however, they graduate into a tangle of bushes above which rise frequent trees. For example, along the southern coast of Asia Minor the lower mountains are clothed with scattered trees and occasional bushes which give an open, friendly aspect like a park. Higher up, however, toward the level where the coolness and moisture of the mountains cause them to be clothed with pine forests, there is a bushy belt almost impossible to cross. The subtropical trees which make up the dry forest, although not conifers, are likely to be evergreens like the laurel, olive, holly, and live oak. This is an advantage, because the winter temperature in these latitudes is often quite high and as the rain comes chiefly in winter, the trees can grow even at that season. This makes up in part for the dry summer when growth must cease.

(7) *Prairie.*—In the table of Fig. 90 a belt of prairie or steppe is shown in latitudes slightly higher than those of the subtropical dry forest. As a matter of fact, as appears on the map, subtropical dry forest, desert, prairie, and deciduous forest all occur in the same latitudes in both North America and Eurasia. The forests occur near the coasts and the deserts and prairies in the interior. The distribution of prairies depends on the season of rainfall and the kind of soil. Grasses are such assertive, tenacious plants that they can drive out the trees in places where trees could grow if nothing else interfered with them. Thus large parts of the American prairies and the steppes of Russia and Hungary are located in regions where certain kinds of trees can flourish if they are protected when young. The grasses, however, because of their more rapid growth and greater hardiness, have driven out the trees. Over most of the prairie region the rainfall is apt to be deficient in the spring when the trees especially need it. Hence when seedling trees begin to grow they are at a disadvantage and are strangled by the more rapidly growing

grasses. If such a region is swept by fires or is grazed by herds of animals like the buffalo, the grass and seedlings both suffer, but the grass springs up again in a few weeks, while the young trees must start from new seeds and hence are ousted in the long run. Because of their stimulating climate and rich soil, the prairies hold high rank in both agriculture and civilization, as is shown by our own Middle West.

(8) *Deciduous Forests.*—In the eastern United States and western Europe the prairies give place to deciduous forests. These are composed of trees like the maple, beech, oak, and poplar, that drop their leaves in the autumn. They grow in places where the winters are cold but not extremely long and where the summers are not only warm, or even hot for a while, but have plenty of moisture all the time. These are the regions of cyclonic storms and of abundant rains at all seasons. The regions of deciduous forests are so excellent for men that they have been largely cleared and to-day support some of the world's densest populations, and contain the great manufacturing centers and the countries that stand in the forefront of civilization.

(9) *Coniferous Forests.*—In an average latitude of about 50° the other types of vegetation merge irregularly into vast forests of spruce, fur, pine, hemlock, and similar coniferous trees which thrive where the winters are long and cold, and the short summers warm and rainy. This evergreen forest forms a great belt across Canada and another from Sweden through Russia and Siberia. On the whole the coniferous forest is too cold for agriculture. Hence it has been occupied by settlers only in the southern portions. The rest still stands as the world's greatest forest reserve outside the tropics. Where the coniferous forest region is inhabited, the people are generally in a high state of civilization.

(10) *Tundra.*—Nearer the poles the coniferous forest gradually breaks down into a belt of bleak, grassy tundra. The seasons are too short for any vegetation except grasses together with lichens and other small hardy forms. No agriculture is possible. The reindeer, caribou, and muskox, however, can get a living, though they must often paw away the snow to get at the plants beneath. Hence, civilization is very low as we see in the extreme northern part of Asia and North America.

(11) *Polar Deserts.*—Near the poles in latitudes above 75° the temperature is almost everywhere so low that no vegetation can exist unless it be minute bacteria. Therefore this region consists of polar deserts like northern Greenland and Antarctica, which are wholly devoid of inhabitants.

It is worth noting that in polar deserts it is not the temperature alone which prohibits the growth of plants. The long period when the ground is frozen prevents the plants from getting enough water. There is no way in which loss of water by transpiration can be balanced by absorption of water through the roots.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Classify the types of vegetation in the country around your home according to Fig. 90. What effect have the various types upon man's life?

2. Draw a graph showing the approximate percentage formed by each of the following in your county: (*a*) land in crops; (*b*) grassland; (*c*) uncultivated pasture; (*d*) productive woodland; (*e*) waste land. Explain the geographic conditions which give rise to these proportions.

3. What percentage of trees in your region lose their leaves in winter? Make as full a classification as possible of the different kinds of trees in your vicinity and of their uses.

4. Classify the main crops of your county according to their uses and according to the kind and amount of ground which they occupy. The Census returns will give you the figures with which to check your observations.

5. It is often stated that the lack of forests in China is due to the constant cutting of the trees and that this had led to a change in climate. Modern research gives no support to the idea that deforestation causes climatic changes. What do you conclude as to the cause of the absence of forests in China, taking into consideration the following facts: (*a*) the length of the growing season in northern China as shown by some of the temperature and rainfall curves in this book; (*b*) the relation of tree growth to rainfall in spring, summer and autumn, respectively; (*c*) the fact that southern China has many trees while northern China has few; (*d*) the relative density of population in north and south China (Figs. 37 and 38); (*e*) the fact that parts of the United States, like eastern Kansas, with a particular type of seasonal distribution of rain, are treeless while regions like England, with no more rain but a different seasonal distribution, have many trees.

6. "Wheat is merely a cultivated grass and will grow anywhere on the natural grass lands of the earth." Examine carefully the truth of this statement. The answer may be put in graphic form by superposing two maps, one showing the natural grass lands of the world and the other the areas of wheat production. A written interpretation should accompany your map.

7. A few years ago numbers of advertisements appeared in England emphasizing the advantages of rubber plantations in Burmah. Study the climatic maps and find out whether the climatic conditions justify such advertising.

8. From Fig. 89 estimate the relative areas where vegetation is seriously restricted by aridity versus temperature. How does each type of restriction influence transportation and interfere with the general intercourse of the different parts of the world.

9. In the text savannas receive more space than prairies, deciduous forests, or coniferous forests. On which of the following grounds is this justifiable: (*a*) degree of familiarity to the average reader, (*b*) amount of space actually covered as shown in Fig. 89, (*c*) importance to civilization?

# CHAPTER XIV

## VEGETATION AND MAN IN THE WARMEST REGIONS

### SECTION I. LIFE IN THE EQUATORIAL RAIN FOREST

**Equatorial Rain Forest.**—It seems strange that the finest vegetation should be associated with the most backward types of men. Such is the case in equatorial regions, where high temperature is accompanied by abundant moisture at practically all seasons. The trees are often so huge and leafy that their lofty tops form an almost unbroken canopy through which the sun rarely shines. In these dense equatorial *rain-forests* the trees are often covered with bright-colored parasitic plants, while long vines, or leaves, hang down like great living ropes. Near the ground there is little vegetation except where the death of an old tree has left an opening. There hosts of young plants grow so fast that they seem to be racing, the prize being life for those that attain dominance, and death for the rest. As shown in Fig. 89 such forests occur in the Amazon basin eastern Central America, west central Africa, the East Indies, nortneastern Australia, and the parts of India on the seaward slope of the main mountain ranges.

**Handicaps to Health.**—In such regions man is subject to most serious handicaps. He has little energy, because the damp, steady heat never changes and never invigorates. He suffers terribly from malaria and other tropical diseases. When ground was being broken for a railroad in the forest of eastern Guatemala the management dared not keep the West Indian laborers at work more than two or three weeks at a time. A longer stay would almost surely have led to death from malignant malaria.

Along with the trying conditions of climate and disease go a host of insect pests and other little irritations. In Liberia, for example, moths eat up clothing; cockroaches devour bookbindings and swarm in the detached cookhouse which takes the place of a kitchen; rats climb to seemingly inaccessible locations and leave nothing but the fragments of the treasures they have eaten; white ants consume the sills of houses and the rungs of chairs, which collapse most unexpectedly; driver ants sweep through the house, and every other creature from man to lizard must vacate even if it be in the midst of rain and the dead of night; "jiggers" bore under the skin of the foot and lay their eggs; fleas bite; the damp heat produces rash against which the lightest clothing feels like nettles. These things and a hundred others are irritating enough at any time, but through the blur of a "touch of sun" or the haze of a burning fever they assume proportions out of all reason. The odors, the mists, the sights, the sounds get on the nerves; the heavy, drooping, silent, impenetrable green forest everywhere shuts one in like a smothering grave; the mind grows sick, and the body follows.

**Scarcity of Beasts of Burden.**—A second great handicap in equatorial rain-forests is the difficulty of keeping domestic animals even in the clearings. Noxious insects plague animals almost as badly as they plague man. For example, in large parts of tropical Africa the bite of the tsetse fly not only causes the deadly sleeping sickness in man, but is fatal to domestic animals, for even the donkey is not immune. Even if animals escape disease, they rarely thrive, for what little grass can grow among the luxuriant trees is usually so rank and coarse that it is not nutritious.

**Difficulty of Transportation.**—The difficulty of keeping domestic animals emphasizes another great handicap of the equatorial forests, namely, the difficulty of transportation. If the natives attempt to travel through the forest without roads, they encounter swamps, great projecting roots, dense thickets, and other obstructions as bad as anything our ancestors met when they first settled in America. They are also likely to be attacked by wild beasts and snakes, as well as by poisonous insects. Suppose someone has energy enough to clear away the forest for a road. New plants spring up almost overnight, and grow 10 to 20 feet in a year. The map of Quintana Roo, the densely forested and uninhabited southern part of the Yucatan peninsula, for example, shows a number of roads, but when a traveler wishes to follow them he is told that they do not exist. They were kept open a few years when *chicle*, the sap from which chewing gum is made, was being gathered, but when this work was finished the trails were smothered in vegetation within two or three years. A macadam road or even a railroad may suffer the same fate, although more slowly. On the railroad that runs from the Gulf of Mexico to the Pacific Ocean across the isthmus of Tehauntepec, for example, men must be exployed to cut the bushes every few months. Where communication is so difficult, people naturally can profit little by intercourse with others who bring new methods and ideas. Bolivia, Peru, Ecuador, and Colombia suffer greatly because the equatorial forests which begin on the eastern slope of the Andes hamper communication with the Atlantic side of the continent, and so with Europe.

**Difficulties of Agriculture.**—Another and even greater handicap of the equatorial forest is the difficulty of carrying on agriculture. When our forefathers cleared the forests of America their task was child's play compared with the clearing of an equatorial forest. Not only did they encounter smaller trees than those of the tropics, but they cut pine, birch, beech, and other soft woods most of the time, and not mahogany, teak, rosewood, and other tropical species as hard as oak. They cut the trees in the cool bracing autumn or in winter when a man wants to work fast in order to keep warm. Think how different it would have been if they had had to cut oak trees on the muggiest kind of hot summer days. When the trees have been felled the difficulties of the would-be farmer in the equatorial rain forest have only begun. On our farms at home it is hard work to keep down the weeds, but suppose the weeds grew a foot or two a month, and kept on growing twelve months in the year. How could anyone keep them down! The useful plants would be choked almost before they sprout from the seeds. That is what happens in the equatorial rain forest. Unless the inhabitants possess a vigor far surpassing that of the best farmers of the temperate zone, successful agriculture is impossible.

**Natives and White Men in the Equatorial Rain Forest.**—We are apt to look down upon the almost naked Papuans of New Guinea, Pygmies of Central Africa, and aboriginal Indians of the Amazon basin. We wonder at people who still live by hunting with poisoned arrows, who make their homes in little huts in the trees or on poles, who run and hide at the sight of a stranger, and who have nothing that can be called civilization. We ought rather to pity them, for even we, with all our opportunities, have not yet learned how to cultivate the lands in the equatorial forest, maintain good roads, and avoid the enervating effect upon health and character. We do these things in the Panama Zone where many people are gathered in a small space, where vast sums of money are available, and where everyone is under government orders, but that is very different from the ordinary forest region. No wonder the natives make little progress.

Vegetation grows so rapidly in regions of equatorial rain forests that they might be the most productive parts of the whole world, provided men knew how to cultivate them. As yet, however, we obtain from them only rubber, chewing gum, quinine, mahogany, and other forest products. The natives are employed by the white man to search for the trees from which these products are derived, but such work does not advance civilization. In temperate regions trees of one kind often cover many square miles, but within the tropics a great variety of species usually grow together. So the natives wander through the forests, climbing tall trees sometimes to look out over the top of the forests and pick out specimens of the species they are seeking. Then they tap the rubber trees and collect the sap, or call the axman to chop down a fine rosewood tree. Their overseers are often brutal white men who have come to the tropics simply to get rich. Unchecked by the restrictions of civilization such men use the most outragous means to gain wealth or to compel the natives to do what they wish. Disappointment and ill health make them more and more brutal, so that they often treat the natives most cruelly. Altogether the natives are by no means improved by their work for the white man. They merely get a pittance which they spend for drink or for useless finery. They are isolated not only from the rest of the world, but from one another, for their mode of life permits only the scantiest population. For in spite of our twentieth century progress the equatorial rain forest still remains almost the worst environment for man.

## Section II. Life in Tropical Jungle Regions

**The Appearance of Tropical Jungle.**—The equatorial rain forest does not occupy the whole of the warmest regions which form the subject of this chapter. Parts of it are occupied by less luxuriant types of vegetation. As one passes from the equatorial regions of greatest and steadiest rainfall, the size of the trees and the density of their stand diminish. Tropical jungle, the second heading in the table of Fig. 90, takes the place of the dripping rain forest, and the conditions of life correspondingly improve. This does not mean that the vegetation is small or scanty. Large trees still grow in abundance, but among such kinds as mahogany, teak, rosewood, and logwood, one finds also a bewildering variety of palms, bamboos, tree ferns, bananas, canes, and many shrubby types. In drier regions prickly creepers and thorny shrubs add to the variety of plants. For miles the tangle of vegetation is often so dense that one can penetrate it only by cutting a path through the living wall. Now and then a group of chattering monkeys goes swinging through the tree-tops, parrots with harsh voices call attention to their own beautiful colors, and the jaunty crow of the jungle cock reminds one of the barnyard. Occasionally an elephant is seen browsing on the bushes, deer jump through the openings, wild pigs, dogs, and rodents scamper through the brush, while tigers, leopards, and other beasts of prey lie in wait on low branches or prowl in secret paths hidden from the sight of man.

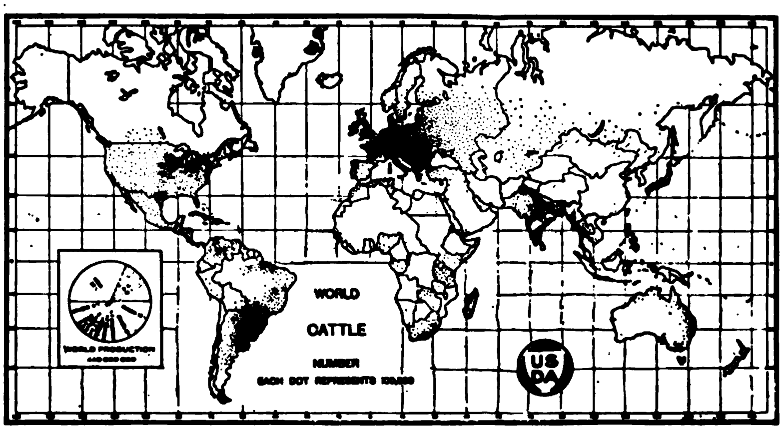
**Ease of Jungle Life.**—In regions where tropical jungle still prevails in its natural state, the people get a living with little effort, provided the population is not dense. The cocoanut and banana furnish food with practically no work, the big fruit of the papaw supplies a family with a meal for the plucking. Wild rice in Siam, yams in Central Africa, the edible seeds of the bamboo in southern India, can be gathered when needed. Elsewhere the breadfruit tree, the sago palm, the sugar palm, the jack-fruit tree, and many other food-producing plants need only be planted and protected in order to furnish abundant food. Life is relatively easy and the natives have little to spur them to effort. Clothing is a luxury, not a necessity; houses need to be little more than a thatch of palm leaves set on a rude frame of poles; wood for building and cooking can be picked up anywhere. Under such conditions we should not expect much progress in the well-watered jungle regions of southern India and Ceylon, Indo-China, the East Indies, Central America, and large areas on the borders of the dense rain-forest in Africa and South America. These are the places which we think of as typically tropical. They form by no means all of the tropical zone, for rain-forests on the one hand and grass and dry scrub on the other occupy vast areas. Yet regions that were originally covered with jungle are the home of the majority of tropical people.

**The Primitive Character of Jungle Agriculture.**—The lowest and easiest type of agriculture is found in the sparsely settled parts of the tropical jungle. It consists of planting a few palm trees, banana plants, and other fruit trees. After that, as is jokingly said, the native has nothing to do except lie under the trees and wait for the fruit to drop into his mouth. Such agriculture, if we may call it by that name, is a step toward civilization, but only a slight one, for it does not stimulate the natives to steady work.

In the more densely populated tropical countries a somewhat higher type of agriculture prevails. The bushes and smaller trees of the jungle are hacked down and the larger trees are killed by cutting off a girdle of bark. At the end of the dry season the brush is dry enough to burn. Then the primitive farmer goes over the burned field with a pointed stick making holes into which seeds are dropped. A little rough weeding is carried on until the young plants are large enough to take care of themselves. That is all the work until harvest time. The easiest food to raise is such starchy tubers as yams and the common sweet potato, or such starchy roots as the cassava or manioc from which our tapioca is made. Several soft varieties of Indian corn, the common pumpkin, and various kinds of beans furnish a supply of food more healthful and more lasting than the roots.

the roots. They also require more careful planning and more work, and thus have a correspondingly greater effect in promoting industry.

**Difficulties of the Tropical Farmer.**—(1) *Rapid Exhaustion of Soil.*—Agriculture in tropical countries is more difficult than in the temperate zone. In the first place, the soil is easily exhausted, or spoiled by the accumulation of bacteria. The constant heat and moisture cause dead vegetation to disappear so completely and rapidly that the soil contains little humus and hence little nitrogen. Other plant foods are also scarce, for as soon as the soil is decomposed by weathering, the heavy rains leach them out. Thus although the first crop is often most bountiful, later ones diminish rapidly, especi-




*Courtesy of U. S. Department of Agriculture.*

FIG. 91.—World Distribution of Cattle.

ally when corn and millet are planted and bacteria become abundant. Hence many jungle farmers clear a new patch of jungle every two or three years, and often every year.

(2) *Tough Grasses.*—In densely populated regions the same land must be used year after year in spite of the scanty crops. Here other troubles arise. For instance, if other weeds are kept down, tropical grasses, like witch-grass but far worse, often overrun the land. In the Philippines "cogon" grass has been the ruin of thousands of farmers who have tried to use fertilizers and otherwise follow modern methods so as to keep the same field in cultivation for a number of years. As the grass often grows as high as a man's head and has correspondingly tough roots, no ordinary animals can drag a plow through it.

(3) *Sparsity and Poor Quality of Domestic Animals.*—The difficulties due to the poor soil and rank grass are increased by the fact that in the jungle regions domestic animals generally thrive only a little better than in the equatorial rain forest. In proportion to the population, the United States, for example, has nearly thirty times as many horses and mules as India, and 50 per cent more cattle, even though Indian buffaloes as well as the common humped cattle are included. Moreover, the Indian animals are of poor quality, undersized, ill-fed, and ill cared for. Hence not only are they unable to plow tough sod, but they supply only a small amount of manure, especially in the moister regions, where animals are least abundant and fertilizer is most needed. Even in moderately dry parts of India animals are so scarce and fertilizer so valuable that people often pay for the privilege of having goats and sheep herded on their fields during the night.

(4) *Insect Pests.*—As the climax of his difficulties the tropical farmer has to contend with all manner of insect pests, rusts, blights, and bacterial infections. They are worse than those of the temperate zone almost in proportion to the greater luxuriance of vegetation. Thus although the farmer can get a living without much difficulty, he is greatly handicapped when he attempts new methods.

When to the handicaps of poor soil, tough grass, few domestic animals, and insect pests we add the lack of energy which is natural in a tropical climate, it is not strange that through long ages the jungle farmer has acquired the habit of not caring whether he makes progress or not. If our ancestors had lived for centuries in such a region, we should probably be as inefficient as the present people of the tropical jungle.

**The Careless Rice Farmer of Ceylon.**—The inefficiency of tropical people is well illustrated by the way in which rice is often raised. When the fields in the wet districts of Ceylon, for example, have been thoroughly saturated by the first rains of the season, or by water turned on from irrigation ditches, the soil is turned up with a rough spade or wooden plow and then trampled with the feet until it becomes a creamy paste of mud on which the seed is sown broadcast. When the seed has germinated, water is again admitted, and the rice left to grow until harvest time. Then the water is turned off and the crop ripens upon dry ground. The grain is harvested with sickles and is threshed by being trodden under the feet of bullocks. It is winnowed in an equally primitive fashion by being thrown into the air from flat basketwork trays, and caught again, while the chaff is blown away.

The people who practice this primitive mode of rice culture are astonishingly indolent. For instance, in 1903 the inhabitants of a certain district in Ceylon raised an unusually large crop of rice. They thereupon sat down to eat it, and raised not a blade of rice the next year. The third year their seed rice was almost all they had left. This was sown, but the crop was largely destroyed by caterpillars. Then these lazy people who had not worked for nearly two years appealed to the government to keep them from famine.

**The Skillful Rice Farmer.**—Although such occurrences are typical of tropical people, they become less common where more careful methods of rice culture are employed. In many regions, for example, the rice seed is sown in prepared beds. Then after five or six weeks it is painstakingly transplanted to the fields which have been carefully plowed and manured. The rice fields are surrounded by mud embankments so constructed that water can be held there week after week, not standing perfectly still, but gently moving. The beds are occasionally weeded with care and finally the crop is harvested promptly so that the ripe grains may not fall out and be lost. Under good conditions 50 pounds of rice will furnish seed for an acre of transplanted rice, and the yield will be 2500 pounds or fifty-fold. This amount, when combined with some beans or meat to furnish protein, is ample food for five adults a year. Thus a population of 2000 per square mile is possible. On that basis all the people in the United States could be supported on an area equal to New York State.

**How the Best Rice Farming Promotes Civilization.**—Rice culture is a distinct help in promoting civilization. For one thing, a rice farmer can profitably keep cattle. Even though the animals are small, they can plow the soft soil of the weedless rice fields. As they can be fed on rice straw the scarcity of good grass is not important. They also enable him to use the same fields permanently, for they supply manure, and thus the soil does not become exhausted.

In the next place, since the enrichment of the soil enables the farmer to devote his energies to one particular piece of land he is likely to build new rice beds, take care that he has a good supply of water, and that all his little ditches and dikes are in good order. He finds that the work of one year gives him much benefit the next. Moreover, he cannot go off and leave the rice crop untended, for a few weeks of carelessness will ruin it. All these conditions cause the careful rice-raising people of India, Java, and Indo-China to be more industrious and reliable than other tropical farmers. For the same reasons they are more hopeful and progressive, since they have learned that their efforts are not in vain. Moreover, as the population where rice is raised is much denser than elsewhere, wild animals do less damage than in other tropical regions, roads can be maintained, and the people can get more stimulus from one another and from outsiders.

FIG. 92.—"Paddy" Fields on Terraces in Ceylon..
**Showing how rice culture promotes industry in the region of tropical jungle.**

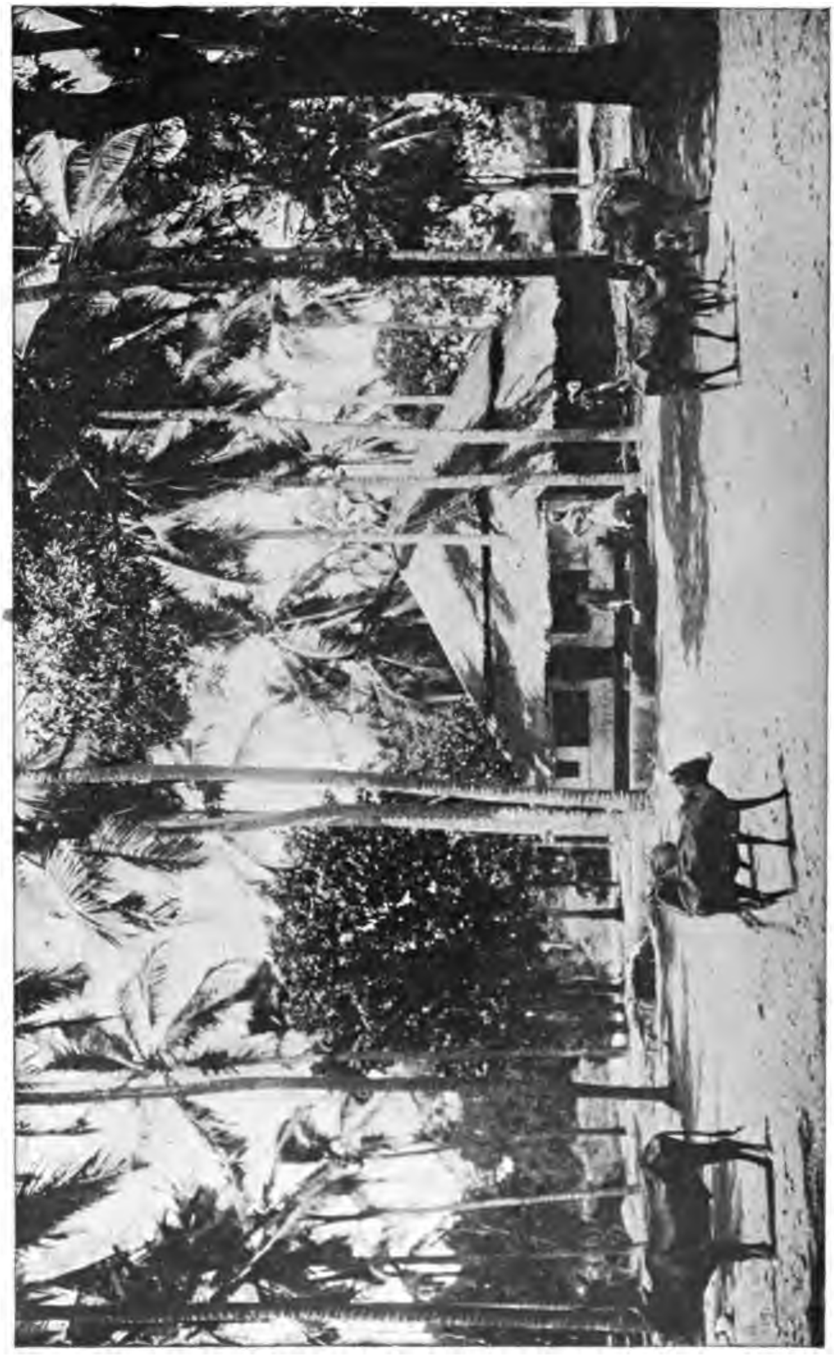


FIG. 93.—A Mopea House in Malabar.
In this region reclaimed from the jungle note the thin scrawny cattle, the palm trees, and the heavy thatched roof to keep out the rain.

## Possibilities of Plantation Agriculture

**The Products of Tropical Plantations.**—In addition to rice farming another kind of tropical agriculture is helping to promote civilization. It depends on the fact that the people of more bracing climates are willing to pay good prices for tropical products. Before the days of steam navigation when Europeans rarely came to the tropics, there was no agriculture for export. The rule of tropical farmers was "Grow only what you need and consume only what you grow."

When Europeans came to the tropics, however, they began to want tea, coffee, cocoa, rubber, and other products. These at first were luxuries, but fast became necessities. In general they are not like the staple food crops which have to be planted each year. They are tree crops which do not require frequent renewal. Hence they are raised in large plantations where the same kind of tree or bush is planted over wide areas. Coffee is a good example. Although small quantities are raised in regions such as Java, Ceylon, Central America, and Mocha, where it first became known, four-fifths of the world's supply comes from Brazil. There hundreds of thousands of acres of tropical jungle have been cleared of most of the trees, and coffee bushes have been planted in the shade of the rest. Tea flourishes under similar conditions, although it grows over a wider range of latitude than coffee. It is raised in great plantations on moist sunny slopes not only in places like Ceylon and the lower Himalayas north of Calcutta, but especially in southern China.

In the same way Europeans and Americans have established large plantations for the cultivation of the cacao tree, from whose seeds chocolate and cocoa are made. Some cocoa comes from tropical Africa, particularly the Gold Coast and the Island of Saint Thomas, and from Asia and the East Indies, but still more is derived from the jungles of Central America, the West Indies, and the northern part of South America.

Bananas grow in the same regions with tea, coffee, and cocoa. They prefer the moister parts of the jungle on the borders of the equatorial rain forest, and grow well in broad lowlands. In Central America, the West Indies, and the northern part of South America great corporations from the United States have cleared thousands of acres of jungle and planted it with this easily raised fruit. One great company employs many thousand men and has regular lines of steamships to bring bananas and other tropical fruits to New Orleans, Baltimore, Philadelphia, New York, and Boston.

Rubber is raised in much the same way as bananas. The principal plantations are in Ceylon, the East Indies, and the Malay

Peninsula. Part of the world's supply, to be sure, still comes from the wild trees of the forests of Central and South America, but the plantation is of constantly increasing importance.

Still other tropical plants such as the manilla hemp of the Philippines—the best of fibers for strong twine and rope—have their home in the jungle, but are gradually being raised more and more exclusively in plantations. The same is true of indigo, which is still raised in large quantities in India and Java in spite of the great use of aniline dyes made from coal tar. Quinine, the great remedy for malaria, is another article which was formerly derived from wild trees. Now, however, the cinchona tree from whose bark it is made is cultivated in plantations not only in the Andean countries of its origin such as Bolivia and Colombia, but in Java, Ceylon, India, and Jamaica. The sweet bark of the cinnamon tree, raised especially in Ceylon, is another sample of the many kinds of tropical products which are being more and more used by Europeans and Americans, and which lend themselves to plantation agriculture.

**Sugar as an Illustration of a Plantation Product: Its Importance.**—The most important of all plantation crops is sugar. Two hundred years ago, the average person in England consumed less than 4 pounds of sugar per year, and the average American a decidedly smaller quantity. Before the Great War the average English consumption was almost 100 pounds, and the American over 80. To-day sugar has become such an important food that the average English-speaking person consumes a third as much of it as of wheat. Ordinarily people do not realize the importance of the sugar supply, but during the Great War almost everyone realized it. In New York a temporary shortage actually led to riots in which mobs broke into stores that were supposed to have a supply. For many months no one could buy more than a pound or two at a time, and the names of the buyers were carefully recorded so that no one might get more than his share.

**Sugar from Tropical versus Temperate Regions.**—About half the world's sugar comes normally from tropical countries. A century ago the whole supply came from there. The tropical sugar is made from the sugar cane, a plant from 6 to 12 feet tall and resembling a cornstalk without ears. The rest is made from beets and comes from the most advanced countries such as Germany, France, Belgium, western Russia, and the United States.

Sugar is one of the few products in which temperate and tropical regions compete. The tropical regions have a great advantage because they possess enormous areas fit for sugar and as yet unused. Moreover, the sugar-care is naturally able to yield much more sugar per acre than are beets. The temperate regions, on the other hand, have the great advantage of being located close to the chief markets, so that their sugar saves freight charges, and of being close to a supply of labor that is vastly more efficient and economical than that of the tropics. Because of these conditions the beet and its methods of treatment have been so much improved that where 18 pounds of beets were needed to make 1 pound of sugar in 1836, only a third as many are now needed. The improvement of the sugar-cane, on the other hand, has scarcely begun. Like many other tropical products it is good in its unimproved state and the backward people of the tropics have not thought of making it better. Now, however, the people of the temperate zone are taking charge of sugar production, and during the next few decades we may expect as great an improvement in the cane as has taken place in the beet.

**How Sugar is Raised in the Tropics.**—Sugar is so useful and so easily extracted from the sap that great quantities of cane are raised in little patches in most tropical regions, especially where there is plenty of sun as well as water. This home-made sugar, however, rarely reaches the world markets. Their supply comes from big plantations. Cuba and the other West Indies are the chief sources of the American supply, but almost every tropical country makes some sugar. Most of the plantations are near the seacoast, largely because the coastal regions are not only more accessible than the interior, but are more apt to have the kind of warm damp plains which the sugar-cane loves. Often too, the immediate coast is more healthful than the hot steamy plains a few miles inland. This is particularly the case in countries like British Guiana, where the climate is admirable for sugar, but bad for people. The native labor there is so inefficient and unreliable that it has been necessary to import laborers from the East Indies and India. The contrast between the natives and the imported labor is a good example of the way in which a rice-raising people reaches much higher levels than people whose agriculture has scarcely risen above the point of growing yams.

Many of the sugar plantations, not merely in Guiana, but in most sugar regions, are of large size and highly profitable. In Cuba whence the United States gets most of its cane sugar some plantations employ as many as 5000 people, and have scores of miles of little portable railways which can be laid wherever they are wanted to bring the cane from the fields. In the Hawaiian Islands the absence of any duty on sugar imported into the United States has helped to make sugar the dominant product. In good years profits of three or four hundred dollars per acre are possible. The industry is so profitable that it has been worth while to go to great expense for irrigation.

Water has been pumped in some cases to a level several hundred feet above its source, while in other instances, tunnels have been built through mountains to bring the water from the windward side, where it is deposited by the northeast trades, to the dry, sunny leeward side where the cane grows fastest provided it is well watered.

**How Plantations Promote Civilization.**—Plantation agriculture is beginning to have an important effect upon tropical civilization. In places where there are no plantations white adventurers still send the natives out into the jungle to gather wild cocoa, wild cinchona, wild rubber, and even wild hemp and wild bananas. The natives live as they have always lived. If they have enough to eat, they stay at home no matter how eager the white man may be to complete a load for his vessel. If one day's work gives food enough for three days, they work only a third of the time, no matter how much the white man complains. If they contract malaria or other diseases in the jungle they die without care or medicine.

On the plantations these things are beginning to be changed. The plantations are usually owned and managed by Europeans or Americans who have a permanent interest in them. On the best and most profitable plantations the employees are obliged to live in better houses, and take more care of health and sanitation than tropical people ever thought of before. Drains are dug, stagnant pools are filled, and other measures are taken to get rid of mosquitoes and other disease-bearing insects. Machinery is introduced, and the natives are taught to use it. At first they are rarely competent for any but the simplest tasks. Little by little, however, they acquire skill and industry. Preference is given to those who work regularly, keep their huts neat, obey the health regulations, and show evidence of willingness and ability to learn the complicated methods of the white man. Another incentive to progress is the desire to imitate the white man and purchase some of the luxuries displayed in the company stores.

On the plantations health is considered of great importance. Hospitals are provided not only for the white man, but for the natives. Where the government does not support them as in Ceylon, they are often run by private companies, as a matter of economy. The largest fruit company in tropical America regularly deducts 2 per cent from the wages of its employees from the highest to the lowest, and uses the money as a fund to protect the general health. Thus the strength of the natives is not sapped by disease so much as formerly, and they are better able and more willing to do hard work.

As the plantations increase in number, the population grows more dense. In certain places such as parts of Java the land is so fully occupied that there cease to be large waste areas where lazy natives can pick up a living on wild fruits. Thus while the plantations provide the opportunity for steady work, they are also making it less easy for people to get a living unless they settle down to such work. Of course it is still difficult to find tropical people who will work except when compelled to do so by hunger, but the standards of life are beginning to rise. This is bound to happen more and more, for the tropical zone to-day offers perhaps the largest and richest of all fields for the investment of capital and brains.

**The Successful Plantations of Java.**—Java under Dutch rule has carried the plantation system farther than any other country. There rice-growing and plantations under European management combine to encourage steady work to a degree scarcely equaled in any other tropical region unless it be Barbadoes and Jamaica. As one result the population has increased enormously. We have no figures for earlier times, but in the last forty years, *without immigration*, the population has doubled. On the less rainy north side of the island where tropical jungle prevailed before it was cleared, large areas support from 1000 to 1200 people per square mile. This is even more dense than the population of manufacturing countries like Belgium and England. Yet so rich are the lands near the equator that Java does not raise nearly as much food as she might if her people had the energy of the temperate zone.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Which of the elements of geographic environment (Fig. 1) first led Europeans to explore the tropics? Which elements now furnish motives to the greater part of the Americans and Europeans who go to the tropics? Explain in detail the geographical conditions which make it far more necessary for Americans and Europeans to keep in touch with their old homes when in the tropics than when they go to places like New Zealand and Siberia? Why is it more necessary for Europeans to keep in touch with the tropics than for Americans?

2. In the Statesman's Yearbook or elsewhere look up the exports of a tropical land mentioned in this chapter. Classify the exports under the following heads: (*a*) products of wild vegetation; (*b*) products of plantation agriculture; (*c*) non-vegetable products. What geographical reasons can you see why one or another of these types of products should come from each specific country?

3. Examine the areas covered by the colonial empires of England, France and Russia. Classify these lands according to the vegetation zones in which they lie. From the Statesman's Yearbook find out the three chief products of a country typical of each zone.

4. (*a*) Write an advertisement for a land company with large holdings in the tropical jungle of Venezuela. Let every statement be absolutely true, but emphasize the advantages.

(*b*) Write a criticism of your own advertisement pointing out the disadvantages a settler would find in taking up land, clearing it, building a house and barn, raising and harvesting his crops and getting them to market. Show in what respects a settler from Wisconsin or from your own State would be especially annoyed by his own ignorance or by his inability to get the kind of labor, transportation, food, and other necessities that he is used to.

5. Look up in the *National Geographical Magazine* or elsewhere an account of the struggle to render the Panama Zone healthful. Write a short résumé of this health campaign in its relation to geographical conditions.

6. In the government reports on Foreign Commerce and Navigation, and in the Statistical Abstract of the United States, look up six plantation products from tropical countries. Make a table as follows and arrange the products in order according to the increase in their per capita use:

| A | B | C |
|---|---|---|
| Product | Percentage of increase in imports *per capita* for 20 years. | Chief countries of origin. |

7. In Brazil the number of immigrants arriving during the year before the Great War was as follows: Portuguese, 28,000; Spaniards, 19,000; Italians, 16,000; Japanese, 4000; Poles, 3000; Syrians, 3000; Austro-Hungarians, 1000; French, 700; English, 500. Determine which of these settlers would find it easiest to adapt themselves to (*a*) the coffee regions; (*b*) the drier grassy region of the interior; (*c*) the Amazon valley. Consider this question from the point of view of (1) health; (2) agriculture; (3) customary methods of house building; (4) use of animals.

# CHAPTER XV

## LIFE IN SUBTROPICAL AND MONSOON REGIONS

**How East Coasts Differ from West Coasts in Latitudes 20° to 40°.**—Nearly half the people of the earth live between latitudes 20° and 40°. In these latitudes each continent shows a strong contrast between a sparse population on the west side and a dense population on the east. This is because the west has its rainy season in winter, and is driest in summer, while the east receives its rains in summer. In each case the dry season is due chiefly to the subtropical belt of high pressure. The winter rains of the west coast regions are due to the invasion of cyclonic storms. The relatively dry and sparsely populated west coasts are called *subtropical*. The summer rains of the east coast regions, on the other hand, are caused by a similar invasion of the subtropical belt by the monsoons which aid the trade winds in bringing moisture from the ocean. Hence the relatively moist and populous east coasts may all be called monsoon *regions*. In general the corresponding parts of the various continents in similar latitudes have the same kind of climate except where this is modified by the size, shape, and relief of the lands and by ocean currents.

**Where Subtropical and Monsoon Regions are Located.**—In Eurasia the comparatively dry subtropical regions comprise southern Spain and Portugal, southern Italy, Greece, Turkey, and Persia, to which should be added the neighboring parts of North Africa bordering the Mediterranean Sea. These, it will be seen, include practically all the most famous empires of antiquity, such as Rome, Greece, Babylonia, Syria, Egypt, and Carthage. The corresponding populous monsoon regions on the east side of Eurasia are the great Indo-Gangetic plains of India, and most of China Proper. These, too were the seats of ancient civilizations.

In South Africa the tapering of the continent brings the subtropical and monsoon regions so close together that both are included in the Union of South Africa. Yet the contrast between the dry subtropical region of the west coast around Cape Town and the wet monsoon region of the east coast around Durban in Natal is scarcely less than between Greece and China, for example. In Australia the two regions are much farther apart, but the contrast is much the same as in South Africa. Western Australia is so dry that its population is only one in three square miles, while in Queensland and New South Wales on the east the rains are so favorable that the population is twenty times more dense.

In the western hemisphere the dry subtropical regions of northern Chile contrast strongly with the wet monsoon or trade wind region of southern Brazil and Uraguay. In our own country California and Utah share many of the qualities of the Mediterranean subtropical regions, while Georgia and the neighboring States have the monsoon qualities of abundant summer rain and a fairly dense population.

**A Subtropical Region Contrasted with a Monsoon Region.**—Let us compare a typical subtropical and a typical monsoon region and see how they differ. Suppose a friend should ask you about the famous Turkish province of Aleppo and the equally famous Chinese province of Shantung on opposite sides of Asia in latitude 34° to 38° N. Could you tell which has the greater population; which would be a better field for a big irrigation project; or which would offer a better market for reaping-machines, leather, hoes, or cotton cloth? Could you tell in which place one could buy horses, camels, or sheep, or in which new varieties of pigs or watermelons might be found? When you understand the difference between subtropical and monsoon climates, you will easily answer these questions and many others with no help beyond a good map.

**A Visit to a Typical Subtropical Region.**—Suppose you were to land at Alexandretta in August and proceed inland to Aleppo, the capital of the province of the same name. You could easily hire a carriage for the dusty drive of 60 or 70 miles, but it would be more interesting to travel on horseback along one of the many trails. The mountains, which must first be crossed, are covered with typical subtropical vegetation. Sometimes it is scrubby dry forest. Elsewhere it is grass so dry and barren that you wonder what supports the flocks of sheep that follow the ragged shepherd boys as they pipe on shrill, wooden flutes.

The people live in the valleys. Beside every spring of sufficient size stands a village surrounded by vineyards and by groves of apricot, mulberry, fig, and poplar trees. Aside from a few patches of melons and onions there are few vegetable gardens. Each village, however, possesses broad, unfenced fields of pale yellow stubble where cattle are now browsing. Two months or more ago the grain was cut, and the circular threshing floors of smoothly packed earth were piled with golden wheat and paler straw, or perchance with barley. Then the grain was threshed by the feet of oxen and donkeys driven around and around over the straw. Now some of it is waiting to be carried home, for the Oriental does not hurry. In spite of its long stay in the open air, one sees no evidence that it has been wet by rain.

In the villages the houses are made either of sun-dried adobe bricks or of stones plastered with mud. Some have low pyramidal roofs covered with red tiles, but most of the people can afford only flat earthern roofs, which have to be rolled after every rain to keep them hard. The women, being Mohammedans, conceal their faces, but one occasionally gets glimpses of them at work grinding flour in hand mills, or doing other household tasks. The men and boys seem to spend most of their time loafing. As the traveler dismounts they spread a rug for him under the mulberry trees beside one of the little reservoirs that hold the limited water supply. Then they bring coffee from Mocha in Arabia, and wheat bread, mutton, melons, grapes, and the sour milk called "leben" or "yowort."

At the base of the mountains on the edge of the great inner plain each of the larger valleys has a village at its mouth, and fields of dry stubble extend for miles. As the traveler proceeds across the plain, however, the villages and fields become less and less frequent, until finally a group of low black tents appears beside a well, with a flock of sheep and a drove of camels not far away. He has reached a region too dry for agriculture. and fit only for desert nomads, who wander with their animals in search of water and pasture.

**The Trade that Might Flourish.**—While riding through this country, you would perhaps say to yourself, "Not much chance to sell leather here. From the hides of their numerous animals the people can get all the leather they want, but this might be a good place to buy either undressed hides or wool. Not much market for hoes, either, for the vegetable gardens are small and grain does not need hoes, but these people ought to plow their broad fields with something better then wooden plows and reap them with machines instead of hand sickles. How good those melons were? We ought to have that kind at home."

**Why Manufacturing Does not Flourish.**—Then you might fall to wondering why manufacturers do not thrive when there seems to be so much unemployed labor. During the reaping season, and again in the fall when the seed is sown, the people work willingly but slowly from dawn till dusk, but between whiles they are idle. Partly because of the hot, monotonous summers and partly for other reasons, such as lack of education, the people are not sufficiently energetic, ambitious, and inventive to save up capital and build manufacturing plants which would keep them busy when there is not much farm work.

**A Midsummer Visit to a Typical Monsoon Region in Eastern Asia: Transportation.**—A visit to Shantung at the same season as our Aleppo visit would show a very different scene. Even at the steamer landing in Tsing-tau there are no carriages and animals. The only vehicles are those drawn or pushed by men. For passengers there are jinrikishas, like overgrown baby carriages, while for freight and baggage there are wheelbarrows with the wheel in the center half way from front to back, instead of at the end. In the interior away from the few railroads, you would find it impossible to hire even a "'rikshaw," because there are no roads for these two-wheeled vehicles. As there are no riding animals you would probably decide to walk and have your baggage carried on a wheelbarrow.

**Density of Population.**—In Shantung one meets twenty people to one in the Turkish province. There are villages everywhere, made of adobe as in Turkey. Unlike the Turkish villages, however, they are rarely surrounded by trees, and stand bare and gray in the midst of the fields. The mountain slopes are not given over to flocks and shepherds as in Turkey, but are covered with terraces, each of which is a little field banked up with a wall of stone or earth. Out on the plains in striking contrast to the Turkish province, the population is more dense than among the foothills. No room here for nomads and camels or even for many domestic animals. A cow or a horse needs several times as much land for its support as does a man. So numerous are the villages that there is not land enough to raise food for any animals except pigs and chickens, which do not need room for pasture, and can be fed on refuse.

**How Intensive Farming is Carried on.**—In Shantung small fields and gardens seem to be the rule rather than broad fields such as we saw in Aleppo. This is no place for complicated farming machinery; it is the land of the hoe. In southern Shantung, both men and women are wading about in rice fields, pulling up weeds and repairing little dams in the irrigation channels. Elsewhere the chief crops are wheat, millet, Indian corn, and vegetables. Some of the people are carefully carrying refuse to the fields in pails to serve as fertilizer; others are hoeing the ground for a new crop after radishes, beans, or peas have been harvested. Still others are setting out seedlings that have been raised in beds as our greenhouse men raise tomatoes and pansies. Thus two or three crops are often procured where we would raise only one.

**How the Monsoon People Supply their own Needs.**—So busy are the people that they scarcely take time to sleep. Even in winter they work harder than the peasants of most countries. In their homes they weave cloth, make rope, and prepare their crude utensils.

They also economize in every possible way. For example, they mend their clothes till the patches hide all the original cloth. It would seem as if manufacturing ought to thrive among such people, but in recent centuries they have not shown much inventiveness, and hence manufacturing has made little progress. Accordingly it would seem as if the enormous population of China would offer a fine market for cheap cloth, knives, hoes, and other inexpensive manufactured articles. The only trouble is that because the people are so numerous and uninventive, they are wretchedly poor and have only slight purchasing power.

**The Effect of Winter Rain and Summer Drought in Subtropical Regions.**—As we have already seen, the striking difference between the provinces of Aleppo and Shantung on the two sides of Asia is

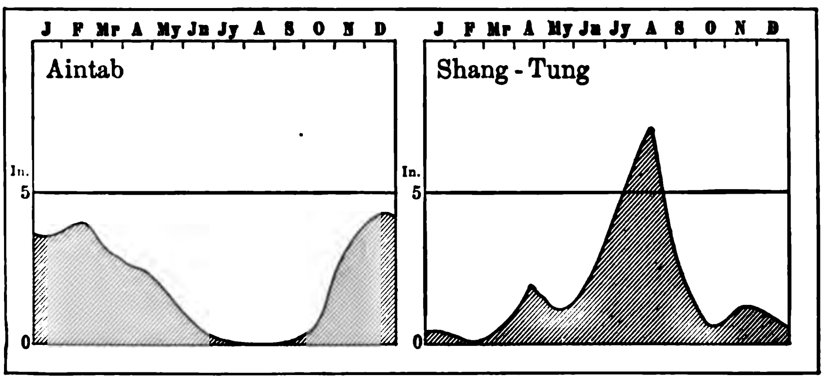



FIG. 94.—Subtropical Versus Monsoon Rainfall.

due largely to the rainfall—not the amount, for in that respect Shantung has only a slight advantage, but the season at which it falls. In Fig. 94 compare diagrams A and B, showing how much rain falls each month in the two regions.

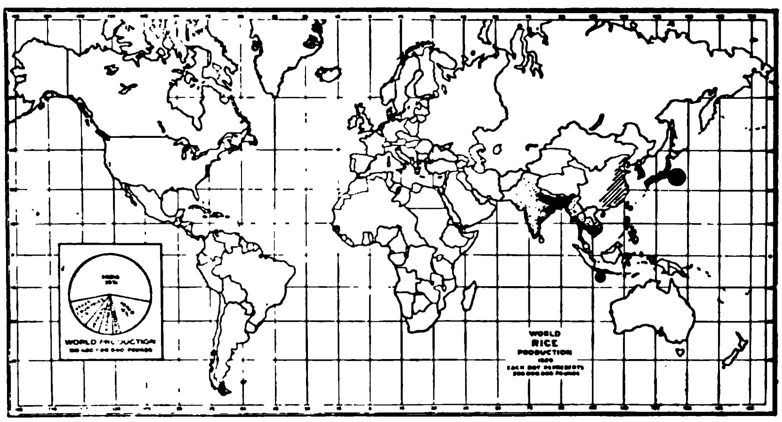
In the subtropical climate of Aleppo abundant rain normally falls during the winter from November to March, but the summer from June to September is practically rainless. Hence corn, beans, potatoes, and most vegetables will not grow well without irrigation. The same is true of oats, rye, millet, and the kinds of wheat and barley that are planted in the spring. On the other hand, *winter* wheat and barley grow excellently without irrigation. The seed is sown in October and November, when the rains first become abundant; it sprouts before the weather is cold, grows a little during the mild, open winter, and is ready to grow rapidly in March, April, and May. The dryness from May onward is favorable to ripening, and makes the work of harvesting easy, since there is little trouble from storms. The fields of stubble furnish pasture for animals during the dry summer when other pasturage is especially difficult to find.

**The Effect of Summer Rain and Winter Drought in Monsoon Regions.**—Look again at Fig. 94, and note the contrast between diagrams A and B. When the subtropical rainfall of Turkey is coming to an end in May, the monsoon rainfall of China is beginning. China gets its rain in the warm season when it is most needed. That is why the population is so dense. Since the rains fall on mountains and plains alike, all the land that is not too steep can be cultivated. There is no room for roads or for cattle, and the whole country is a vast patchwork of gardens. Wheat and barley thrive best in the north; millet, corn, beans, and root crops like beets and turnips grow excellently everywhere; while rice flourishes in the south. Millet and rice are the staple foods in such a climate. They yield enormous returns under intensive cultivation. This type of agriculture is highly characteristic of monsoon regions and is another reason why they are able to support so large a population.

**Why Famines Occur in Regions of Seasonal Rainfall.**—In one respect subtropical and monsoon countries are alike. Both are particularly liable to famines. To begin with monsoon countries, famines are worst in China and in India. Long ago in the years 1344 and 1345 India experienced such a terrible famine that even the Mogul emperor is reported to have been unable to obtain sufficient food for his huge household. As recently as 1877 five million people are said to have perished from hunger in India, and almost ten million in northern China, while in every recent decade millions of people have suffered. In both countries the reason for the famines is the same. Since practically all the people are closely dependent upon agriculture, the prosperity of the whole country depends upon a short season of abundant rain in summer. Every few years the rains are either scanty or come so late that the crops cannot mature before the end of the growing season. Sometimes the delayed rains pour down in such a deluge that they flood the rice fields too deeply and destroy the prospects of those seemingly fortunate ones who have been able to start their crops by means of irrigation. Elsewhere the heavy rains gully the slopes and carry away the precious soil that should raise the crops of future years. Disasters by flooding are most severe in China, while the failure of the rains has probably produced the worst effects in India.

Subtropical countries occasionally suffer from famines which would be as bad as those of China and India if the population were equally dense. Syria, for example, has lost its people by the hundred thousand on account of drought. Its famines are caused either by the failure of the rains to begin at the proper time in the fall. or to continue late enough in the spring.

Such famines are one of the important reasons why most monsoon and subtropical regions are backward. As equatorial regions are held back by excess of rain, so these regions suffer from insufficient rain. A drought of a single month at the critical time is enough to cause dire distress. For generations the people have suffered such disasters, and this has helped to make them hopeless and therefore inefficient. One of the most interesting questions of the future will be to see how fully the Zionists in Palestine with the advantages of



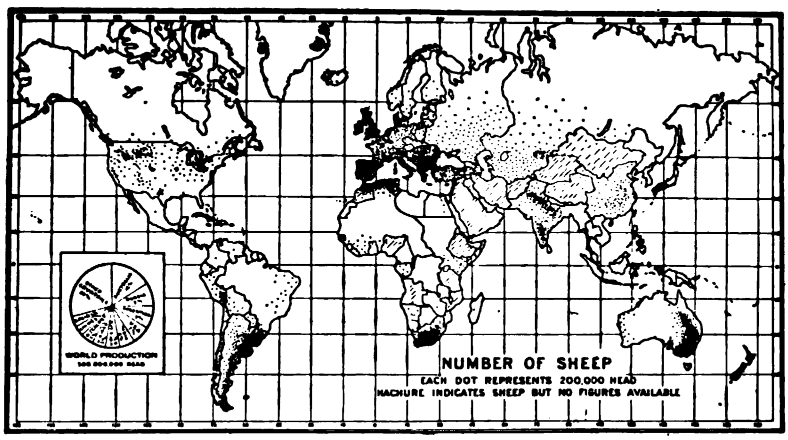

*Courtesy of the U. S. Department of Agriculture.*

FIG. 95.—World Production of Rice, 1920.

good government, modern methods and abundant capital can overcome the handicaps which have hitherto retarded most subtropical countries.

**Mediterranean Subtropical Regions.**—The most important of subtropical countries do not suffer from famine as do those of Asia, for they are located in Europe and have a better rainfall than the rest. They are Italy, Spain, and Greece. With them may be grouped the countries of North Africa that border the Mediterranean Sea. Since Europe, Asia, and Africa really form one great land mass penetrated by such gulfs as the Mediterranean and Red Seas, this whole group of countries actually lies in a position corresponding to that of California. They are so important that the term "Mediterranean climate" is often used instead of "subtropical climate." They contain not far from a hundred million people, which is four times as many as the subtropical regions of the rest of the world, but less than a quarter as many as the monsoon regions of Asia.

On the whole the Mediterranean countries are more advanced than the Aleppo province which we have used as a type. Even Italy, the most progressive, however, is behind California. All alike are notable for their extensive irrigation, and for their great crops of wheat, barley, and fruit. Yet there are great differences among them. For example, in Turkey and Morocco most of the farmers use crude wooden plows tipped with a bit of iron; they thresh the grain under the feet of oxen; and winnow it by throwing it into the wind. In Greece and Tripoli such plows are also used, but much less commonly. The




*Courtesy of the U. S. Department of Agriculture.*

FIG. 96.—World Distribution of Sheep.

threshing floors are often of stone; a roller or sledge with short teeth like a harrow is used for threshing, and a hand machine for winnowing. In Spain wooden plows are found in out-of-the-way regions, but a good many modern steel ones are imported together with some threshing machinery. In Italy the island of Sicily is as backward as any part of Spain, but farther north almost everyone uses modern implements, although generally of a simple type.

**The North American Subtropical Region: The Advantages of California.**—Although the southern half of California has a typical subtropical climate, it is more favored than even the best of the corresponding Old World regions. The chief reason for this difference is that although the winters have about the same temperature, the California summers are not nearly so hot as those of the Mediter-

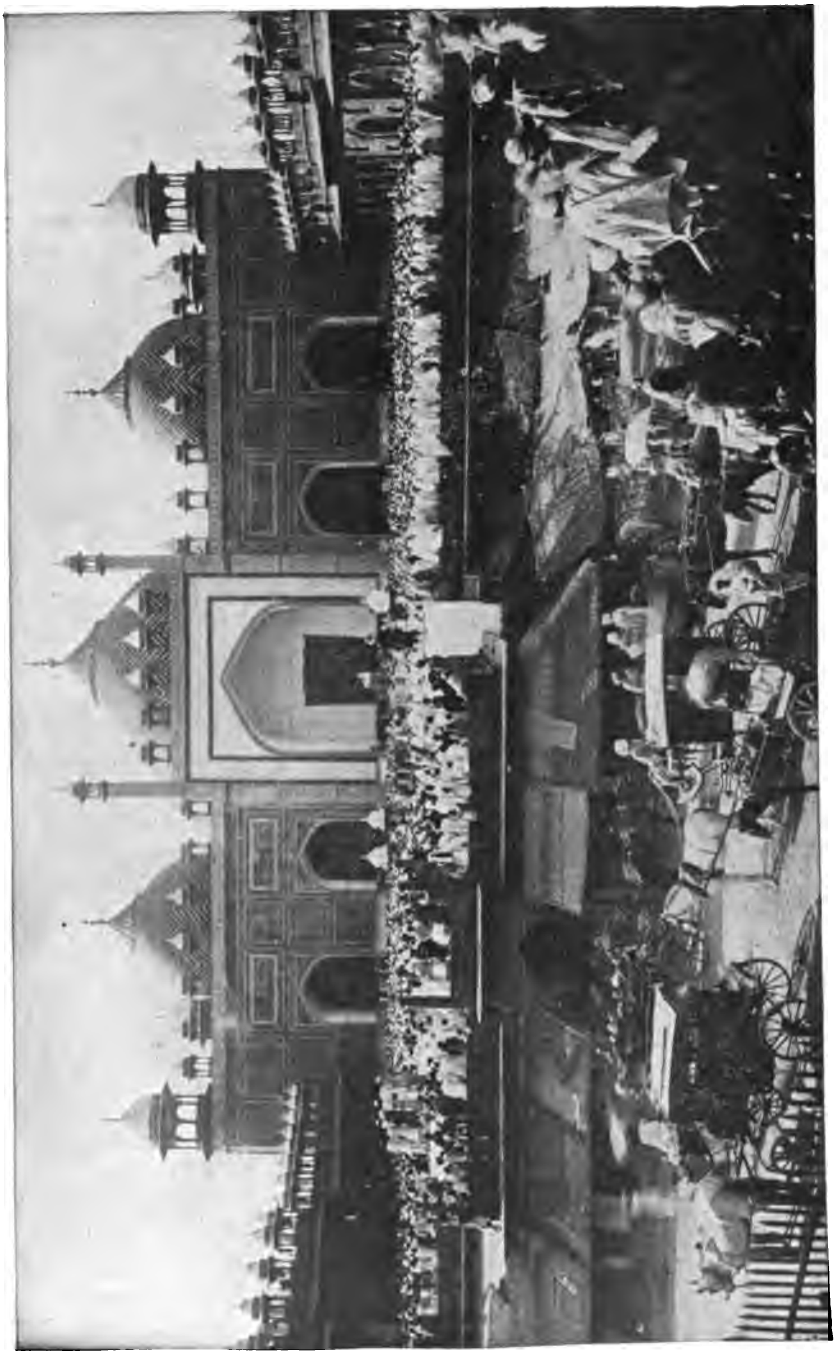


FIG. 97.—Service at a Mohammedan Mosque in Northern India.

A sample of the architecture of a monsoon region.

ranean regions. Thanks to the presence of the cool Pacific Ocean the summer temperature at Los Angeles averages about 11° F. cooler than at Beirut, which lies in the same latitude and is directly upon the coast instead of twenty miles inland. Similar differences prevail throughout the coastal regions. Hence California has a great advantage, for the energy of the people is not sapped by extreme heat, and the ground does not become parched so rapidly through rapid evaporation. Another advantage of California is that its mountains are much higher than those of Aleppo and Syria, and therefore furnish much larger supplies of water for irrigation.

**Subtropical Farming in California.**—(1) *The Pastoral Stage.*—Agriculture is the great industry of California. The products of the farm are worth three times as much as those of all the mines, oil wells, and quarries. Even the manufacturing industries consist largely of the preparation of farm products.

The agriculture of California has passed through three stages in which grass, grain, and fruit have been successively the most important forms of vegetation. The first white settlers were Spaniards from Mexico. They depended solely on grass, for they raised cattle in enormous numbers. The animals thrived on the broad plains, for the thick green grass which is so lovely in the spring when it is spangled with bright flowers, is equally nutritious when it becomes dry and brown in the summer. Up to 1848 hides and tallow were almost the sole Californian products. So eager were the Spaniards to make room for more cattle that they killed large numbers of horses. A live horse was no more valuable than his hide.

The discovery of gold in 1848 and the consequent increase in population checked the cattle industry, for bread as well as meat was wanted by the new settlers. In 1862-64 a fearful drought, such as sometimes comes to subtropical countries, gave a still greater check, for it destroyed thousands of cattle. Then sheep-raising assumed great importance until the flocks threatened destruction both to the forests and to the grasslands where the sheep nibbled off the seedlings and grasses to the very roots. In the drier parts of California and among the mountains cattle and sheep are still the mainstay of many of the people, but elsewhere they are much less important than in better watered States like Wisconsin.

(2) *The Wheat-raising Stage.*—After the discovery ot gold, a second stage of agriculture began in California. Wheat became the staple crop, just as in the subtropical regions of Turkey. The size of the ranches accordingly decreased, while the population increased. Wheat-raising, to be sure, requires large farms, but not nearly so large as does cattle raising. In 1850 the average ranch contained about

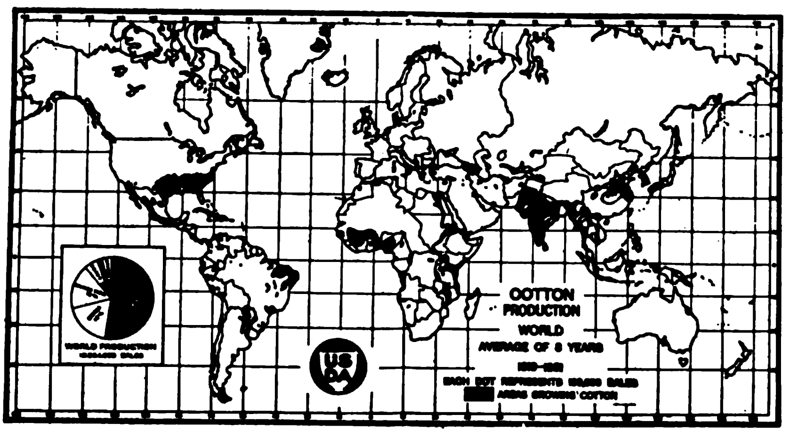
4500 acres, and some comprised several hundred thousand acres. Ten years later the average farm was only one-tenth as large. Now the size has fallen to about 300 acres and is still declining rapidly. Nevertheless some farms are still so enormous that in the morning ten or twenty plows start from the barns and take all day to make a complete trip across the field and back.

The level nature of the great interior valley and the size of the wheat farms has led to the introduction of remarkable machinery. Great gangplows drawn by steam engines or by twenty or thirty horses plow a dozen or more furrows at a time. Equally wonderful harvesting machines are used. Drawn by twenty-five or thirty horses or propelled by gasoline engines they cut, thresh, and sack the standing grain in one operation at the rate of two bushels a minute. Such machinery can be used only in regions where the harvesting season is dry and sunny as in subtropical California, for only the thoroughly dry kernels can be threshed while the grain is being cut. One man's work with modern machinery in California harvests as much grain as the work of twenty or thirty in Turkey. Since 1880 when California harvested 54,000,000 bushels of wheat the production has fallen off, but this is partially compensated by a great amount of barley. Much land which cannot be irrigated will always be better for grain than for anything else.

(3) *The Fruit-raising Stage.*—So long as California devoted itself largely to raising cattle and cereals the chief advantage of its farmers over those of Turkey lay in greater energy and skill. During the last forty years, however, the State has reaped another great advantage from the abundance of the water in its mountains. To-day California depends for a large part of its wealth upon irrigation. The irrigated farms are generally of small size and are devoted chiefly to fruit, with some vegetables. With the possible exception of parts of Italy and Spain there is no part of the world where fruit is more abundant. The beautiful plum orchards of such places as Santa Clara County furnish more prunes than any similar areas in the world. Equally remarkable are the hundreds of square miles of green vineyards in Fresno County and elsewhere. The California grape is known everywhere, and is converted into famous raisins, and grape juice. A still more wonderful scene is the orange groves of the south, especially in the valley from San Bernardino to Los Angeles. Literally millions of trees with their polished leaves and symmetrical round shape are so loaded with yellow oranges that one scarcely can believe them to be natural. For the high quality and great abundance of its fruit California is indebted not only to irrigation, but to the dry sunny weather in the summer and fall. How important

this is may be judged from a comparison with Florida. Although that State raises a third as many oranges as California and a far larger supply of grape fruit, it raises less than 1 per cent as many grapes, apples, pears, peaches, plums, and other orchard fruits.

The necessity of exercising great care in order to sell their fruit in the distant markets of the East has led the fruit growers to combine their interests. Practically every community has a co-operative packing house where fruit is cleaned, sorted, and packed, and from which it is shipped to meet the demands of the market. In the hands of a people who are full of ambition and energy the great natural resources of California together with such co-operative enterprises



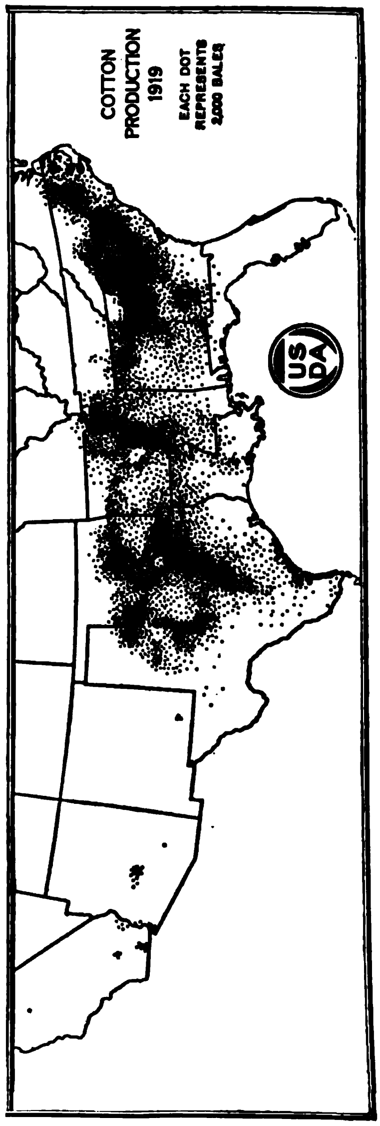

*Courtesy of U. S. Department of Agriculture.*

FIG. 98.—World Production of Cotton.

have made the State the most prosperous and progressive of all subtropical countries.

**The Monsoon Region of America.**—Florida and the neighboring coastal districts belong to the monsoon type, since the prevailing winds blow from the northwest in winter and the southeast in summer. No part of the Atlantic coast, however, shows a rainfall of the purely monsoon type, for cyclonic storms supplement the monsoon rains. In summer the rainfall of Florida, as appears in Fig. 83, is of the typical monsoon character. By November it has fallen off so that it seems to promise a dry season, but cyclonic storms cause the rain to increase again. Except for the heavy frosts which sometimes follow in their wake, and the consequent damage to the orange groves, these storms give the southeastern United States a great advantage over Southern China and India. Not only does the occurrence of rain at all seasons prevent such complete crop failures as afflict the Asiatic monsoon countries, but the frequent storms bring stimulating changes which help to make the people energetic.

Farther north, as appears in Fig. 83, the rainfall of the Carolinas shows only a little monsoon influence, and is almost as abundant in winter as in summer.




*Courtesy of U. S. Department of Agriculture.*

FIG. 99.—Cotton Production in the United States, 1919.

**Why the American Monsoon Region Has Fewer People than the Asiatic Regions.**—Since Florida and the neighboring States combine the advantages of abundant monsoon rain in summer and cyclonic rain the rest of the year, we should expect a dense population. Florida, however, had only 18 inhabitants per square mile, in 1920, and even Georgia only about 50, while the monsoon regions of China and India had about 500. There are three main reasons for this, (1) soil, (2) climate, and (3) newness.

(1) In Florida the relative sparsity of population is due partly to the abundance of swamps like the Everglades. A more important factor, both in Florida and the neighboring States, is that the coun-

try consists largely of sandy soil which has recently emerged from the sea and which is in constant need of abundant fertilizers. Moreover, in all warm, wet regions the soil does not have enough humus because vegetation decays so rapidly. In India and China, however, the monsoon regions with the densest population contain great delta lands and broad flood plains, where the water and silt of great rivers are regularly spread over the fields and renew their fertility.

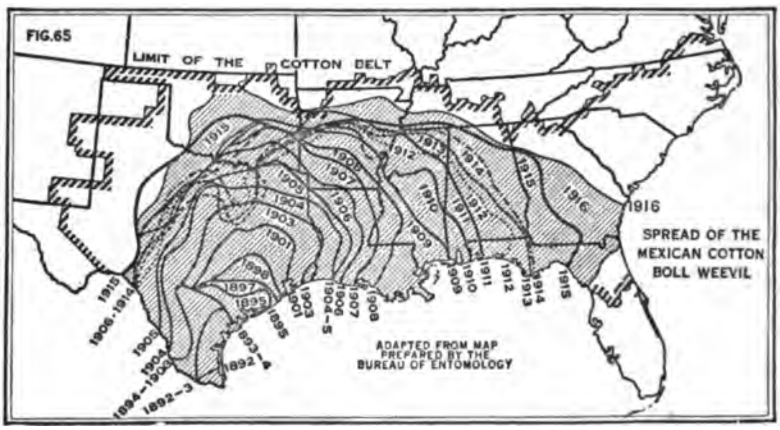



FIG. 100.—Migration of the Boll Weevil.

(2) Although the monsoon climate of the South Atlantic States is highly favorable for agriculture, it has not encouraged immigration. The United States was settled mainly by people from the cool, stimulating climates of northwestern Europe. Such people can live and prosper in the Southern States, but as they themselves say, they do not have so much energy as in the North. This is especially true if they attempt to work in the fields and endure the sun and heat of summer. For this reason, as well as because of the presence of a colored laboring population in the South and the demand for labor in the North, immigrants from northern Europe have preferred to go to the Northern States, which up to the present time have offered so much unoccupied territory that there was room for everybody. This condition is rapidly changing, partly because the North is becoming well populated, and partly because immigrants now come in large numbers from Mediterranean countries, whose people are better adapted to out-of-door work in a southern climate than are the English, Germans, Scandinavians, and other northern immigrants of earlier days.

(3) The chief reason, however, why the population of our Southern

States is so scanty compared with that of the monsoon areas of Asia is that America is still new, even though we think the Atlantic States are old.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Copy from Figs. 78 and 79 the parts which illustrate the contrast between subtropical and monsoon regions. Insert the names of all the places mentioned in connection with Aleppo and Shantung. Add chief products; also the important steamship routes which connect these regions with the rest of the world. Insert blue arrows for prevailing winds in winter and red for those prevailing in summer. On the basis of the maps explain which of these two regions has the greater advantages.

2. Look up the article on architecture in the Encyclopædia Britannica and read the paragraph about the origin of architecture. Look up what J. Bruhnes, in his book on "Human Geography," says about architecture as a reflection of the physical geography of the country. Apply this to the facts stated in the present chapter. Compare the various parts of the United States in this respect. Give examples from your own region, and from any other region with which you may be familiar. In each case suggest reasons for the facts you state.

3. "In countries where communication is difficult sheep are profitable animals to keep." Examine the truth of this statement when applied to Turkey. Consider the following factors: (*a*) the articles of trade obtained from sheep; (*b*) the conditions of transportation; (*c*) the density of population; (*d*) the conditions of industry.

4. Write a description of the products and industries of the Balkan Peninsula modeled on that of the Aleppo region given in this chapter. Facts may be found in the Statesman's Yearbook, the encyclopædia, books of travel, etc.

5. In the Bible, in the writings of Omar Khayyám, and in other literature, find metaphores suggested by the physical geography of the subtropical lands of the Eastern Mediterranean.

6. Read the first chapter of Rudyard Kipling's "Kim," making a list of all the references to food, clothes, domestic animals, occupations, habits, and houses. Discuss the extent to which these show a direct response to the conditions imposed by physical geography.

7. Make diagrams showing the percentages of the world's production of wheat, barley, and rice raised by India, Spain, and Italy, respectively. For each of the three graphs write a statement of how it is explained by the physical geography of the country.

8. Some children from central China who visited Pennsylvania were never tired of looking at the cart horses and marveling at their size and strength. They were also astonished at the number of wild blackberries to be had for nothing, and at the width of the country roads, the frequency of village greens, and the recklessness with which people burned wood. Explain the geographic basis of all their feelings.

9. A. Examine the maps of products in this book (Figs. 53–58, 60–61, 64–65, 91, 95-96, 98-99, 104-5, 108 and in the Geography of the World's Agriculture (published by the U. S. Department of Agriculture). Make a list of all the products for which world maps are available, and of the subtropical and monsoon countries in which they are produced. Classify the products as follows: (1) those produced abundantly;

in (*a*) subtropical countries; (*b*) monsoon countries; (2) those produced moderately in (*a*) subtropical and (*b*) monsoon regions; (3) those produced either not at all in such countries or only in small quantities.

B. For each of the five classes in your list, write a statement of the geographical conditions which determine the extent to which the various products are produced. Fig. 1 will help you. Remember that geographic conditions which affect transportation, health, etc., are as important as those which directly affect the product.

10. Look up the cotton-boll weevil. Study Figs. 99 and 100, and describe the progress of the weevil. Where did it apparently come from? Try to find from the publications of the U. S. Department of Agriculture how far it has now spread.

## CHAPTER XVI

## MODES OF LIFE IN DESERTS AND POLAR REGIONS

THE great deserts that border the torrid zone comprise the intensely hot and dry regions of Arabia, the Sahara, the Kalahari, central Australia, northern Mexico, and northern Chile. These regions are all alike in having the following characteristics: (1) slight rainfall; (2) scanty vegetation; (3) practically no agriculture; (4) dependence of man on animals; (5) a sparse nomadic population; and (6) low civilization.

If we examine the whole world we find that certain other regions also have these six qualities. These other regions are of two types, (1) continental deserts and (2) polar regions. The continental deserts are in most respects like the trade wind deserts. The chief difference is that although most of the year they are hot like the trade wind deserts, they have a period when they are cold like the polar deserts. Nevada and Utah are mild examples of this kind, while the deserts of Central Asia from the Caspian Sea to the borders of Manchuria are extreme examples. The polar regions, which have the six characteristics named above, are not deserts in the ordinary sense for they are covered with snow much of the time and the ground is moist when this melts. Yet in their effect on man the cold regions of Greenland, the northern parts of North America and Asia, the vast continent of Antarctica, and many limited regions at high altitudes like Tibet are much like deserts. Hence in this chapter we shall treat these cold wet polar deserts as well as the ordinary hot dry deserts.

**Sparsity of Desert Population.**—The sparsity of desert population is astonishing. For instance, the desert part of Arabia, omitting the fairly well-watered regions of Yemen and Oman, is as large as the United States east of the Mississippi River. Yet its population is probably less than 2,000,000, while the corresponding portion of the United States has 70,000,000. In southern Arabia over 300,000 square miles of absolute desert have never been explored and probably contain no inhabitants. This area equals Germany and Italy, combined, which contain 100,000,000 people. The great Sahara, which is as large as the United States, probably has less people than the Arabian desert, while the Australian desert has least of all among the dry deserts. In our own country, Nevada has only one person for each square mile, and most of these are gathered in oases such as Reno at the eastern base of the Sierras. Contrast this with Massachusetts, which has 450 people per square mile.

Cold deserts have even fewer people than dry deserts. For instance, if we omit the Labrador coast and the Yukon mining district, the northern provinces of Canada, with an area of 2,000,000 square miles have only about 20,000 inhabitants. This part of Canada is as large as all Europe aside from Russia, but it has only one inhabitant where the European countries have 16,500. Antarctica, the greatest of all deserts, has not a single inhabitant.

**The Effect of Scanty Rainfall on the Appearance of Dry Deserts.**—Dry deserts present a peculiar appearance. Parts consist of mountains and parts of plains. Among mountains the bare rock everywhere sticks out, often painting the landscape with weird colors.

Sometimes it is shattered and broken by the action of frost and sun. Elsewhere it is roughly pitted by the wind. Only in the higher parts of the mountains is the climate moist enough so that there is a fairly deep cover of soil held in place by vegetation.

The weathered rock and soil from the mountains are washed down to the lowlands by the occasional violent rains which fall even in deserts. At the base of the mountains the wet weather torrents deposit their load in great tracts of sloping gravel like enormous beaches from 1 to 40 miles wide. Close to the mountains the gravel consists of large rough fragments, but farther away the materials become more pebbly and sandy, and finally they merge into plains of sand and clay. Often the sand is heaped into dunes while the clay is scoured by the wind into fantastic pillars and tables.

If the mountains furnish water enough the lowest part of each plain contains either a salt lake or else a "dry lake," known as a playa. Such a lake at most times presents the appearance of an absolutely flat expense of smooth clay, but after one of the occasional rains it is transformed into a lake in which the water may be only a few inches deep.

In the well-populated parts of the world vegetation is so abundant that it hides the soil. In deserts, however, the vegetation is so scanty that the traveler is constantly reminded of the rock and soil. What little vegetation he sees, however, is peculiarly interesting because of the strange forms which it has acquired in its attempt to meet the conditions of drought.

**Sandy Deserts.**—Although sandy deserts do not occupy any larger area than those of bare rock, gravel, and clay, they present much the most interesting appearance, largely because of the presence of dunes of every size. That is why the most familiar pictures of deserts show sandy dunes. In the Takla Makan desert of western China millions of sand dunes of many tones of yellow, brown, and pink, look like the waves of a huge dry sea 600 miles long. Only the boldest explorers dare launch their caravans on such a waterless sea. The wind piles the dunes up to a height of 500 feet and thus causes them to be an almost impassable barrier. Even when the dunes are small the feet of men and animals sink into the unstable sand and slip and slide so that progress is extremely slow. Often it is impossible to climb the steep leeward slope of a dune, although the gentler windward slope may be comparatively easy. When violent winds blow the sharp sand with cutting force into the traveler's face there is nothing to do but turn one's back to the wind and try to escape suffocation. The camel has become so well adapted to this condition of desert life that he is able to close his nostrils and only open them at long intervals for a quick breath.

**How Loess is Formed and Used.**—When the wind blows over the desert it not only heaps the particles of sand into dunes, but carries away the finer dust and deposits it in the form of *loess*. From the Takla Makan and Gobi deserts the dust is sometimes blown in such quantities that 60 or 100 miles to the southeast it makes the air so hazy that the sun is hidden even at noon. Beyond the limits of the deserts it falls as a fine yellow powder. It even sifts into the tightly closed houses and makes it difficult to write by coating the paper and clogging the pen. In northwestern China this desert dust has accumulated in some places to a depth of scores of hundreds of feet over an area larger than France. It is very fertile provided it is well supplied with water. Where there is no vegetation to hold it, however, it is so light that it is quickly blown away. Along the roads in the loess country the feet of horses stir up the dust and then it is blown away so that the roads become deep trenches. In spite of its lightness the loess does not easily crumble. Its thick, fine-grained masses can be cut like cheese and it sticks together so well that houses can be excavated in it. Near the borders of the deserts in northwestern China many peasants live in such houses dug in the walls of the sunken streets.

**Why Desert Lakes are Salt.**—Aside from the dunes and the vegetation one of the most striking features of the desert is the lakes. Occasionally they are beautiful, but oftener they have flat muddy shores crusted with white crystals and looking something like tide flats and smelling far worse. Desert lakes generally have no outlets and hence are salty. This is because both in deserts and elsewhere every stream contains a little dissolved salt, although ordinarily this cannot be detected except by chemical analysis. In deserts, however, evaporation removes the water without removing the salt, which in ordinary lakes escapes through the outlet. Hence all the salt that is brought in by the streams remains in the lake, and finally forms a strong brine so heavy that the bather finds himself lifted from the bottom when he walks out as far as his armpits. Woe betide him, in the Dead Sea, for example, if he gets the stinging brine into his eyes or nose. The Dead Sea is well named for there is practically no life in it. Many great salt lakes have dried up, leaving their salt in solid layers, scores or hundreds of feet thick. In Central Asia such salt deposits cover thousands of square miles.

**Types of Desert Vegetation.**—The vegetation of deserts varies from region to region as much as does that of the forests. For example, on the borders of the Transcaspian Desert beyond the Caspian Sea and in parts of the Arabian Desert the whole country seems to consist of nothing but bare sand dunes. Then comes a heavy rain, and within a week or two the sand is covered with a short, sweet growth of grass which makes it look as fertile as the prairie. Yet in a few more weeks the grass has ripened its seeds and dried up, and soon the sand is blowing freely as before. Farther out in the desert grass almost never appears, but the sand is dotted here and there with tough little bushes three or four feet high which seem leafless until one notices the little scales pressed tight against the stems. In some of the greatest deserts where sand dunes rise to heights of several hundred feet the space between the dunes is gouged out by the wind to such a depth that the water table is almost reached. Here one sometimes finds beds of reeds or patches of the feathery shrub called tamarisk. As the dunes slowly advance they may kill such plants, but sometimes, if the dunes are small, the plants may shoot up fast enough to keep their heads above the sand. Occasionally, after the dunes have gone on and again left them uncovered one finds reeds and bushes curiously elongated as if on stilts.

In the gravel deserts the vegetation is even less abundant than in the sand, for there are few favored spots and even when rain comes the plants have hard work to grow. In some of the vaster deserts of Persia and Central Asia the gravel at the foot of the mountains forms expanses like huge beaches 10, 20, or even 40 miles wide. Here the gravel is cemented together by a slightly salty calcareous deposit. Sometimes after this has been soaked by one of the occasional rains it splits into irregular polygons 5 to 12 feet in diameter, and cracks several inches deep are formed along the edges. In these the wind deposits sand, and later tiny plants take root so that sometimes the polygons are outlined in green, like little gardens where the plants occupy the paths instead of the beds. In deserts where gravel is mixed with soil an unusual rain may sometimes cause the desert to blossom as the rose. One would have to travel far to find any scene more beautiful than the Mohave Desert of California at such a time when it is carpeted for miles with the loveliest flowers, white, yellow, orange, and blue.

In deserts like most of those in the United States where some rain falls in both summer and winter, bushy vegetation is the predominant type. The newcomer who sees the abundant sage brush of Utah and Nevada, or the larger greasewood and mesquite of Arizona with the accompanying cactus and the grasses that spring up after rains, can scarcely believe that in a region which looks so fertile agriculture is impossible. Many a tenderfoot from the East has thought to his cost that the westerners were lying when they told him not to take up land of that kind. He found, however, that the types of vegetation which grow in the desert can subsist on an amount of moisture which will not possibly support crops. That is the great outstanding feature of every desert.

**Oases.**—The spots called oases are places where desert vegetation gives place to that of well-watered regions. Although they are in the desert, they are not of it. Yet they must be considered, since they occur in every desert, and support far more people than the vast surrounding areas. Moreover, the true desert people, the nomads, have much the same relation to the oases that country people have to cities. The larger oases are places where streams from the mountains spread out upon the desert plain and serve for irrigation. The mountains and the oases may be as far apart as the snowy heights of the Himalayas and the hot sunny delta of the Indus. The whole of cultivated Egypt indeed, with its 11,000,000 people, is a great oasis watered by the rains that fall on the mountains of Central Africa. In such oases crops like millet, wheat, barley, grapes, and many other fruits are raised. The houses are generally made of sun-dried bricks called adobe. Sometimes, where there are trees enough, the houses have wooden frames, but in the oases of the driest deserts like eastern Persia even the roofs are made of adobe bricks forming small domes. In books we hear much of the beauty of such oases as Damascus, but generally the descriptions are exaggerated. Nevertheless, when a traveler on a camel, the ship of the desert, comes to an oasis where he can rest and supply his needs it seems very beautiful to him just as any port seems a haven of rest to a storm-tossed mariner.

**Palm Oases.**—In the smaller oases of the driest, hottest deserts such as those of Arabia and northern Africa, palm trees are almost the only kind of vegetation. We are apt to think that this kind of oasis is typical, but really it is comparatively unimportant. Such oases are located where little springs bubble out of the earth or in depressions where the ground is slightly moist and wells can be dug. The palms are often planted in pits 5 or 6 feet deep where the soil is moist. At much greater depths water can be obtained in wells. It is raised by hand or by camels drawing buckets at the end of long ropes and is conducted with great care to the pits where it waters the trees.

**Why Desert People Follow the Nomadic Mode of Life.**—Outside the oases the only thing upon which desert people can rely for a living is animals. Sheep, goats, donkeys, and especially camels can live on the scanty vegetation of almost all deserts, but they must constantly be kept moving from one pasturage to another. Hence the desert people are nomadic. Their success depends upon their ability to find for their flocks sufficient vegetation and water. Accordingly it is not surprising that when one meets a Bedouin Arab in the Syrian desert, for example, he at once asks, "Has rain fallen anywhere?" If the traveler reports showers along his route, the Arab hastens back to camp, announces the good news to his family and gives orders to prepare to move. Next morning the tents are taken down, the household goods are gathered up and with the children are put on the backs of camels. In an hour the trampled ground and the blackened stones where the fire has gone out are the only signs of the encampment.

It must not be thought that the Arab rashly moves his camp without knowing where he can get water. He is familiar with all the water holes, springs, and wells, and has special places to which he regularly migrates provided there is grass. Sometimes, to be sure, if the rain is especially abundant and the grass grows thick and green, as occurs at long intervals, he does not need to camp beside a source of drinking water. The animals eat so much green grass that they can get along without water and the people make milk serve for both food and drink. As for washing it is enough for the Arab to rub his hands in the sand. In spite of the fact that the Mohammedan religion especially teaches cleanliness, millions of Arabs have probably lived and died without ever taking a real bath.

**The Property of Desert Nomads.**—Among desert nomads there is nothing that can really be called wealth. Some, to be sure, have larger herds and flocks, better guns, and better clothing than their comrades, but none live in houses or have elaborate furniture. If a man tried to have such things he could not reach fresh pastures and new springs in time to keep his animals in good condition. Moreover, life is so hard that there is no chance to accumulate the surplus that would buy these things. Among the Arabs, for example, poverty is so nearly universal that there are few differences such as exist where some people live in great palaces and others in houses of one or two rooms, and where some perform hard, ill-paid manual labor, while others live in ease upon the accumulated wealth of their ancestors.

The chief thing that keeps the Arabs poor is that the rain may fail and the grass wither at any time. Then the animals begin to suffer from hunger; the mother camels and sheep give no milk, and their colts and lambs begin to die. Soon the Arabs have neither young animals to exchange for rice, millet, and dates in the oases, nor milk to keep themselves from starvation. So long as anyone has food he shares it with his neighbors, but all alike suffer greatly. They dare not kill too many animals for then they would destroy their sole means of support.

**How Poverty Leads to Desert Raids.**—The hardships of the desert cause the nomad's ideas of right and wrong to differ from ours. What is an Arab to do when his camels, his sheep, his wife, his children, and himself are all suffering the pangs of hunger? The only thing that occurs to him is to plunder. Hence he goes on raids. A raid is an interesting event. A group of Arabs are sitting on the ground in a circle at sunset. Suddenly one of them rises and thrusts his spear into the ground. "I am going on a raid," he says. "Who will go with me?" One by one the others quietly but vigorously drive their spears into the sand as a sign that they too will go. Early the next morning a dozen or twenty keen-eyed Arabs ride off across the desert on their camels. A few are leading horses for the final swift dash. On long raids only those horses can be used that have been taught to drink camels' milk. After riding one or two hundred miles the raiders discover a nomad camp which they plan to plunder. Waiting until nightfall the horsemen silently and swiftly drive off the camels which are herded not far from the tents. If necessary the raiders shoot the camel-keeper, but they try to avoid such extreme measures, for if one member of a family or clan is killed, the rest are never satisfied until they take a life for a life.

**How Raids Influence Arab Character.**—We believe that a man should treat his neighbors as he would wish to be treated himself, but through thousands of years the hard conditions imposed by the desert climate have weeded out the Arabs who are not ready for violence. To succeed in the desert a man must be ready not only to engage in plundering expeditions, but to endure heat, thirst, and the weariness of long rides. Unfortunately, however, he has little need of steady industry. When he comes home from a raid or from an exhausting hunt for stray animals, he is so tired that he lies down and does nothing for days. If he is able to summon up his powers when his camels are driven off or his sheep have strayed, his laziness does little harm. The ordinary work of caring for the animals is so light that the women and children can easily do it and still have plenty of time to rest. Hence the Arab is not only dishonest according to our standards, but lazy. He thinks of raids as a part of the ordinary routine of life, and of steady work as something fit only for slaves.

**How Nomads are Governed.**—Nomads who live in tents and go on raids are almost invariably a source of trouble to an ordinary government, for not only are they lawless raiders, but they bitterly resent any outside interference. As the camps are small and widely scattered it is extremely difficult to punish evil doers. Hence patriarchal government, or the "rule of the father" still persists. Each camp is apt to consist of relatives. The father sets up his tent surrounded by the families of his sons and nephews, and often of his grandsons. His word is law. Where several families live together the power is given to a sheikh. Sometimes the office of sheikh passes from father to son, but only when the son's character justifies his authority in the eyes of the clan. Otherwise, the sheikh is elected because of his wisdom, courage, and liberality.

**Good Qualities in the Desert.**—The desert promotes good qualities as well as bad. The traveler is struck by the proud and manly bearing of the bronzed Bedouins. Although fierce and reckless when pushed by necessity, they are faithful unto death when once they have given their word. Hospitality, too, is a universal trait. As the nomad travels about the desert in search of stray animals or on his way to an oasis to buy dates or sell animals he would often suffer severely or even perish if the occasional people whose tents he passes were not willing to entertain him. Even in the tents of his enemies a man finds food and shelter and can remain safely from the evening of one day till the morning of the second day after. So strong is the sense of hospitality that an Arab will make a feast for a guest even if he and his family are obliged to go hungry.

**The Frozen Deserts of the North.**—In cold deserts the nomads depend partly on land animals and partly on those of the sea. Among the Lapps who live in the tundra the reindeer takes the place of the camel. Unlike the Arabs, however, the Lapps are not great raiders. This is partly because famine does not beset them so sorely as it does the Arabs, and partly because they cannot travel so easily.

The Eskimos who depend on sea animals have a harder time than do the reindeer people. In extremely cold countries not only is the vegetation of the sea more abundant than that of the land, but the amount of small floating animal life is more than in any other part of the ocean. Hence along the northern coasts of Asia and America the sea is inhabited by seals and fish which furnish food for polar bears, wolves, foxes, gulls, and other sea birds. All of these animals can be used by man for food. The land furnishes much less food than the sea, for although musk oxen and caribou are sometimes found, they cannot be depended on. Unfortunately the sea animals cannot be domesticated. The seals, fish, bears, and gulls come and go as they choose and the Eskimos, Aleuts, and other coast nomads who depend on them must follow as best they can.

During the summer the nomads live in tents—crude little shelters made of skins and supported in the center on sticks of precious driftwood or large bones like the ribs of whales. The Eskimos have even less furniture than the Arabs, and their tents are less pretentious. In winter such tents are too cold, for the thermometer remains far below zero for months during the long, depressing Arctic night. At that season little hunting can be done, and so far as possible the Eskimo must live on meat that they have stored during the summer. Therefore, having moved to the most southern part of the region which they frequent, they shelter themselves in huts of stone, sod, and skins. Sometimes, however, they are obliged to migrate in search of food even in winter. Then at each camping place they build houses of blocks of snow, with sheets of ice for windows.

The only domestic animal that the Eskimo can keep is the dog, which draws his sledge and helps him in his hunting. The dog can live in the far north because he eats flesh, whereas all other domestic animals except the comparatively useless cat live almost wholly on grass, grain, or other vegetable products. Since most of the animals that are hunted by the Eskimos live in the water, boats are of far more importance than dogs as means of transportation. They are constructed with the greatest skill from sealskin, bones, and driftwood. Few races are more clever than the Eskimo in making the most of scanty resources.

The Eskimos are as notable for their peaceable character as are the Arabs for raids. This does not mean that the Eskimos have higher standards of right and wrong than the Arabs, or that they have greater prosperity. They steal from outsiders whenever they get a chance, and are so poverty stricken most of the time that they would plunder if they could. They refrain from raids simply because raids do not pay. The next encampment may be 100 miles away, for along the whole northern coast of America and part of Asia the Eskimos number only about 30,000. No one has flocks, herds, or other wealth. The chances are nine out of ten that at times when one community is suffering from hunger, their neighbors, even though far distant, are also suffering.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Trace from a map of the United States the boundaries of Arizona, Kansas, and Pennsylvania, putting the three in a row. Insert one dot for each 100,000 inhabitants. Make a table showing the comparative conditions of the three States in the following respects: (*a*) latitude; (*b*) altitude; (*c*) distance from the ocean; (*d*) mean temperature; (*e*) total rainfall; (*f*) season of most rainfall; (*g*) type of vegetation; (*h*) mode of life; (*i*) main industries; (*j*) population; (*k*) density of population. Point out the effect of (*a*) to (*e*), respectively, on each of the conditions (*g*) to (*k*).

2. Write an account of the Egyptians in contrast with the nomads of Arabia. Give statistics as to rainfall, temperature, and density of population for each country. Describe main resources, method of utilizing the resources, types of dwellings, government in its relation to environment, and any other topics that interest you.

3. Look up the article on the *Mahommedan religion* in the Encyclopædia Britannica. Under the sub-heading *Ethics* you will find what are sometimes called the "Ten Commandments" of the religion. How many deal with habits and customs arising out of conditions of nomadic life? Explain.

4. Read some account of Arctic or Antarctic exploration (Peary, Scott, Shackleton, etc., will do. Mrs. Peary's account of housekeeping, etc., in Greenland is excellent), and then classify the difficulties encountered under the following heads: (*a*) food; (*b*) preparation of a dwelling house; (*c*) clothing; (*d*) transportation and communication; (*e*) effect of climate on health through (1) daily conditions, (2) seasonal conditions.

5. Read some account of desert exploration and treat the matter as in the preceding question.

6. Find out what you can about the aborigines and first settlers in Arizona. In what respect were some of their occupations and habits like those of the Arabs? Were there any laws at all similar to those of the Mahommedans? What geographical conditions have done most to diminish the resemblance between Arizona and Arabia?

7. A. In an encyclopædia or general history look up the following subjects: (1) the Huns under Attila and others about 450 A.D.; (2) the Arabs who burst out from Arabia about 650 A.D.; (3) G(J)enghis Khan, who devastated Asia about 1200 A.D.; (4) the Moguls, who swept into India soon after 1500 A.D.

   B. Find out what effect the conditions of life in steppes and deserts have had in forming the success-making qualities of conquerors who came from these regions.

   C. Describe as many ways as possible in which the desert environment reflects itself in the habits and military methods of these conquerors. Some are suggested in the following quotation regarding the Huns: "Trained riders, archers and javelin throwers from infancy, they advanced to the attack in numerous companies of horsemen following hard upon each other, avoiding close quarters, but wearing out their antagonists by the persistency of their onslaughts. Scarce a corner of Europe was safe from them."

   D. The four outbursts of desert people mentioned under A. all took place during periods when the deserts suffered from unusual aridity. Point out what this may have had to do with the matter.

## CHAPTER XVII

## IRRIGATION

**How Egypt Gets its Water for Irrigation.**—In all parts of the world where there is a long dry season irrigation is practiced, but it is most important in monsoon and especially subtropical regions. Forty or fifty centuries ago in the days of the ancient Egyptians and Babylonians it had already reached a high stage of development. In Egypt nature makes it remarkably easy to practice irrigation on a large scale. The White Nile or main stream comes from three of the great lakes of Central Africa which serve as reservoirs and give a large supply of water at all seasons. The Blue Nile and the Atbara come from the highlands of Abyssinia and are subject to great floods which cause the river to overflow its banks during the summer. Thus at that season the river not only waters the land without exertion on the part of the farmers, but fertilizes the fields with rich alluvium. In order to equalize the flow of water and make irrigation possible at all seasons the great Assuan Dam has been built.

**Some of India's Irrigation Projects.**—In India one single irrigation project on the Chenab, a tributary of the Indus, waters 2,500,000 acres and supports a million people. The Chenab Canal was built by the British government to increase the production of grain and relieve the severe overcrowding in other parts of India. Before any land was assigned to settlers the fields, streets, and village sites were all laid out in what was then a desert. Places for the post office, bazaars, and government offices were assigned, and everything was ready. Then 800,000 people poured in within eight years. The canal cost nine million dollars and to-day the crops *each year* are worth about twelve million. Since ancient times southern India has been full of "tanks" or small ponds built for irrigation. In recent decades all sorts of clever schemes have been devised for bringing water from places where it is plentiful to those where it is scarce. For instance, the Cardamom Mountains at the southern end of the western Ghats receive 80 or 100 inches of rain and the plains to the east only 20 or 30. Accordingly the Periyar River draining these mountains on the wet west side has been made to flow through the mountains in a tunnel a mile long. Emerging on the east side it waters the dry plains near the city of Madura.

**Irrigation in the United States.**—The people of the eastern United States rarely realize the importance of irrigation, for in the entire country only one farm in forty is irrigated. Nevertheless in the western part one million people live on fifteen million acres of irrigated land.

The distribution of this land is illustrated in the following table:

IRRIGATION IN THE UNITED STATES

| | Percentage of Total Area Included in Irrigation Projects. | Percentage of Farms under Irrigation. |
|---|---|---|
| Utah | 3½ | 91 |
| Nevada | 2 | 89 |
| Wyoming | 3¼ | 57 |
| Colorado | 9 | 56 |
| Idaho | 6½ | 53 |
| Arizona | 1 | 53 |
| California | 5½ | 45 |
| New Mexico | 1½ | 36 |
| Montana | 4 | 34 |
| Oregon | 4 | 15 |
| Washington | 2 | 15 |

The first column of figures shows what percentage of the total area of each State is included in irrigation projects. These projects include over two-thirds of the 45,000,000 acres which may possibly be irrigated some day. As yet, however, they have been developed only to the point where about half of the area included in them receives water. The second column shows what percentage of all the farms are irrigated. In such a State as Arizona, even though the splendid Roosevelt Dam waters 270,000 acres, there is not water enough to irrigate more than 1 per cent of the total area, and only about one-half of 1 per cent has thus far been utilized. This small fraction, however, includes 53 per cent of the farms in the State. The remaining 47 per cent are mostly cattle ranches, and will probably never be irrigated.

California is much better off than Arizona. It possesses enough water so that 5½ per cent of the land will probably be irrigated before many years. Moreover, among the 55 per cent of farms which are not irrigated a large number are wheat ranches, many of which are of uncommonly large size. The largest single irrigation project in California is in the Imperial Valley. There the waters of the Colorado River, which till 1900 flowed unused through a desert, now support some of the richest farms in the United States. This region closely resembles Mesopotamia and Egypt, and raises certain crops such as dates, the silky Egyptian cotton, and rare varieties of melons which grow almost nowhere else in the United States.

Utah and Nevada depend on irrigation more than any other States, for about 90 per cent of their farms have an artificial water supply. So dry are these States, however, that in spite of the streams

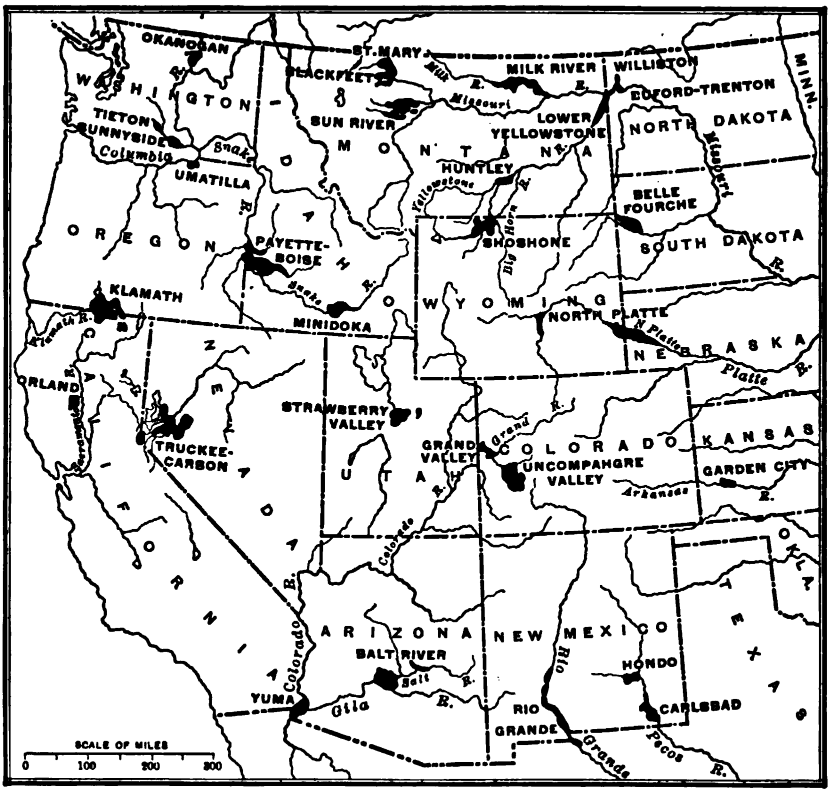



FIG. 101.—Irrigation Projects under Reclamation Act of 1902.

coming from the great Wasatch and Sierra Nevada ranges, the area included in irrigation projects is only 3½ per cent of Utah and 2 per cent of Nevada.

**How Mountains Make Irrigation Possible.**—Irrigation depends largely upon the presence of mountains. This is partly because mountains receive more rainfall than the dry lands at their base and partly because mountains act as reservoirs. The ground water which seeps into them in the rainy season gradually flows out through springs at lower levels. If the mountains are high enough so that the snow lasts till summer, the water is set free when it is most needed for irrigation. That is one reason why India has developed irrigation more highly than has any other country. The fact that both the Ganges and the Indus flow from mountains covered with perpetual snow makes it possible for a fifth of all the cultivated land of India to be irrigated. Northern Italy is another fortunate region. It not only has the snows of the Alps to serve as a reservoir, but some of its rivers such as the Ticino and Adda pass through the beautiful Lakes Maggiore and Como which aid in keeping their flow steady and in preventing floods.

In the preceding table see how the presence of snowy mountains influences the figures in the second column. Nine per cent of the lands of Colorado are included in irrigation projects because that State has great plains lying at the base of the snowy Rockies. A unique irrigation project is located in this State. The Gunnison Valley contains a large river, but only a little flat land, while the neighboring Uncompahgre Valley contains a small river and plenty of flat land. To bring the water to the land where it is needed a tunnel 6 miles long has been dug so that the water of the Gunnison River is now turned into the Uncompahgre Valley. Idaho and California as well as Colorado receive large streams from snowy mountains, and hence the figures in column 1 are comparatively large, while Arizona, New Mexico, and Nevada do not have such high mountains and are less fortunate.

**The Need of Artificial Reservoirs.**—Where the mountains are not high enough to give abundant water throughout the dry season artificial reservoirs must be made such as the Roosevelt Reservoir in Arizona, or the tanks of India. The chief trouble with reservoirs is that unless great precautions are taken they ultimately become filled with silt. India is full of old tanks that have thus gradually been converted into smooth plains which are now cultivated with the help of irrigation from newer tanks.

**Methods of Raising Water for Irrigation.**—In many places the demand for irrigation cannot be met entirely by supplies of water that flow to the fields from mountains or reservoirs. The additional supply must be raised mechanically from streams or wells. One of the most primitive methods of doing this may be seen in Egypt along the banks of the Nile. There the brown-skinned peasants fill buckets suspended from one end of a bar which moves like a seesaw. With the help of a weight at the other end they lift the water to a higher level. There it is raised again by another seesaw and so on until it reaches the level of the fields. In India the most familiar means of

FIG. 102.—A Dam for Irrigation in Northern India.

**Note the great height of the dam. The flare at the bottom is the counterpart of a similar flare on the other side, and is needed to resist the vast weight of the water.**

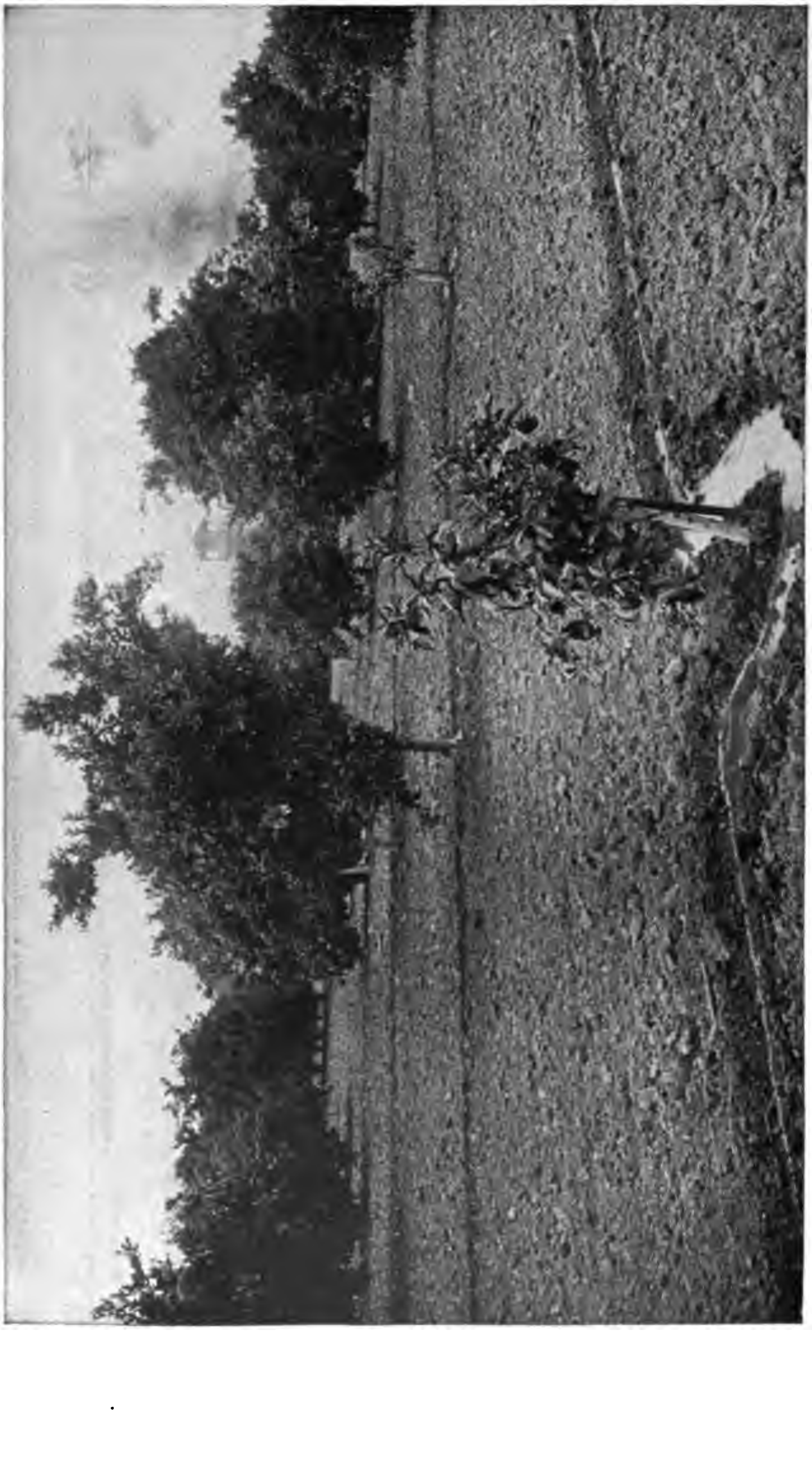


Fig. 103.—An Irrigated Orange Grove in Arizona.
Before this tract was irrigated it was much like Fig. 88.

raising water is from wells by means of a large leathern bag, suspended by a rope passing over a pulley. When the bag is filled a pair of bullocks attached to the end of the rope are slowly driven down an incline, thus raising the bag, which is emptied into a sluice leading to the fields.

These Oriental methods contrast vividly with the practices in many of our own irrigation projects where the water is raised by efficient pumps driven by windmills, by gasoline engines, or by electricity generated by the irrigation water at the dams higher up the valleys. What is needed now is some means of reducing the cost of power. If solar engines were practicable and cheap, irrigation would be possible in many places where it is now out of the question, for the constant sunshine would furnish abundant power at low cost.

**Special Advantages of Irrigated Lands.**—Agriculture in irrigated regions enjoys seven distinct advantages: (1) The soil of dry regions, as we have already seen, is peculiarly rich in plant foods, for the meager rain carries away only a small portion of the soluble ingredients. (2) In addition to the abundant plant food in the original soil new food is often provided, for many irrigating streams deposit mud which serves as a fertilizer. (3) Since the sun shines much of the time in irrigated regions growth is rarely hindered by cool, cloudy weather. (4) Neither do the plants suffer from drought or from too much rain, for they can be given as much or as little water as is needed. (5) Weeds do not grow as they do in wet countries. (6) The fruits grown on irrigated lands can be dried easily and cheaply. (7) Hay and grain always ripen perfectly and can be harvested without getting wet. In rainy lands vast quantities are often spoiled by being rained on at harvest time.

Thus many circumstances combine to produce large crops with only a moderate amount of labor. In the United States the average value of the crops on an acre of irrigated land is from 25 to 65 per cent greater than in the country as a whole.

**Chief Crops in Irrigated Regions.**—(1) *Hay.*—The most valuable irrigated crop in the United States is alfalfa. It occupies 30 per cent of the irrigated land, and often yields from three to five crops each year. Other kinds of hay crops occupy another 30 per cent of the irrigated land. This is not surprising in view of the fact that in the United States as a whole hay is more important than any crop except corn.

(2) *Fruit.*—The next most valuable irrigated crop in the United States is grapes and orchard fruits such as prunes, cherries, peaches, and apples. Subtropical fruits such as the orange and lemon stand next in importance. In other subtropical countries where fewer

animals are kept and less hay is needed the importance of fruits is even greater. For instance, the chief money crop of Greece is little seedless grapes which are sold in our stores under the name of dried currants. Without them the Greeks would not know what to do for ready money.

(3) *Rice.*—Although relatively little rice is raised in the United States, it is the most important of irrigated crops in the world as a whole. The crop in this country grows in the semi-monsoon regions along the Gulf and South Atlantic Coasts. Rice is the only great crop the cultivation of which is limited to irrigated regions. It cannot grow properly unless its roots are bathed for months in slowly moving water. Monsoon countries practice irrigation chiefly for the rice crop, although other crops need it in the early spring before the rains arrive.

**Irrigation Supports Dense Populations.**—Irrigation adds enormously to the density of population. For instance, in the Ebro and Tagus Valleys of Spain much of the land produces twelve times as much as it would without irrigation and therefore supports a corresponding number of people. Utah has an area of 85,000 square miles, but most of the 400,000 people live in the 1500 square miles that are irrigated. There the population is more than 200 for every square mile, while elsewhere it is less than one. In Arizona it is estimated that one person is added to the population for every two acres brought under irrigation, or over 300 per square mile. In the Libyan oasis west of Egypt, which would be uninhabited without irrigation, there are 500 people for each square mile. Egypt is still more remarkable. Its cultivated area, including the long, narrow flood plain and the triangular delta, amounts to about 11,000 square miles, and contains 11,000,000 people, or 1000 per square mile. It is one-fifth as large as Iowa, but supports five times as many inhabitants, or twenty-five times as many per square mile.

The effect of irrigation on the density of population is well illustrated by comparing Mesopotamia and Egypt. Both regions have rivers capable of use for irrigation, and both were densely populated before the time of Christ. Then the people degenerated and were troubled by fierce invasions. Accordingly in Mesopotamia the dams and canals were neglected, and were ruined by disastrous floods of the Tigris and Euphrates. Hence for centuries the formerly fertile plains have had almost no population. Now that the Great War has put this region under the protection of England new irrigation works are being built, and in a few generations the population may be as dense as that of Egypt.

**How Irrigation Prevents Famine.**—One of the most important advantages of irrigation is that it prevents famine. Thus it saves millions of lives, especially in densely populated areas like India and China. In India the British government has not only carried out great irrigation schemes to reclaim deserts, but has spent millions of dollars to irrigate land that needs water only in occasional years of special drought. One such project cost $1,500,000. Its ordinary receipts from the sale of water are not enough by over $60,000 per year to pay interest and running expenses, but in a single dry year, 1896-7, when the crops would have failed without it, this one project enabled the farmers to raise crops worth $750,000 and saved thousands of lives.

In Egypt the floods commonly rise to a level averaging 25½ feet above the ordinary low water level at the First Cataract. In 1877 the flood rose only 20 feet. The difference of 5½ feet prevented the water from flowing to nearly a million acres of land. Terrible famine ensued and the government lost $5,500,000 simply in taxes because the poverty-stricken, famishing people could not pay. The great Assuan Dam was built to prevent the recurrence of such disasters. Behind it the Nile has been converted into a narrow lake 200 miles long so that there is plenty of water at all seasons.

Contrast Egypt's experience with that of China. Although China has many small irrigation works, she has not had a modern government to carry out great irrigation projects. Therefore we are frequently called upon to contribute to relief funds for the millions who suffer from famine. In addition to her primitive irrigation system, China needs great dams, canals, and aqueducts, not only to provide water in times of drought, but to control the water in times of flood. If China's great rivers could be properly regulated, not only would the people themselves be saved from untold suffering, but the wealth of the country would greatly increase to the benefit of other countries as well as of itself. The purchasing power of the country would probably increase so much as to make a difference of scores of millions of dollars each year in the trade of the United States alone.

**How Irrigation Promotes Civilization.**—Irrigation is one of the strongest agencies in promoting civilization. The earliest civilizations grew up in Egypt, Mesopotamia, Northern India, and China, where irrigation has always been of the highest importance. There are at least five distinct ways in which irrigation promotes civilization: (1) People who practice irrigation cannot wander from place to place as do primitive savages. They must stay in one home. Hence every improvement that they make in their houses or fields is of permanent value, and stimulates them to do more.

(2) Such people learn to have forethought, for otherwise their ditches and dams will not be ready, and their crops will not grow. They also learn industry, for they cannot put off their work. If the water is led onto the fields too late or allowed to remain too long there will be a poor harvest. Forethought and industry are at the base of all advances in civilization.

(3) Irrigation also promotes civilization by teaching people to live in peace and submit to the will of the majority. Suppose a number of farmers settle along a small stream in a new country. In a dry year those living farther up-stream are tempted to take too much water, thus insuring good crops for themselves, but ruining those of the people farther down-stream. When such things happen quarrels arise at once. In our own Western States, when irrigation was first begun and before laws had been framed, more than one fight with guns occurred for just these reasons. Such a condition, however, cannot continue. People soon realize that if anyone begins to tamper with the water, all the rest run the risk of serious loss because their own crops may be left dry. Hence strict laws are passed, and public opinion enforces them most sternly. When people learn to obey the law so carefully in one respect, they tend also to obey in others. Accordingly few places are more peaceable and law-abiding than irrigation communities even among people otherwise low in the scale of civilization.

(4) Irrigation also helps to teach self-government. For example, in parts of northern Italy the users of water from a given ditch meet in November and elect representatives to a sort of water parliament representing all who are supplied by one large canal. Each village plans beforehand what crops it will raise the next year. Then the water is divided according to the need of each.

(5) Another way in which irrigation promotes civilization is by causing people to live close together, and yet letting each family have a yard of its own. In California, for instance, the irrigated farms, especially those where fruit is raised, are comparatively small and no one feels that he is far from his neighbors. Where people live compactly in irrigated districts, they are able to support good schools, churches, and other helpful institutions.

## QUESTIONS, EXERCISES, AND PROBLEMS

**1. A.** Use the table near the beginning of this chapter as a basis of a diagram. Let lines of appropriate length represent (1) the area of each State included in irrigation projects; (2) the percentage of irrigated farms.

B. Add to your diagram (3) the proportion of each State which is mountainous and (4) the population per square mile. You can estimate what part of each State is mountainous by studying relief maps.

C. On an outline map of the United States insert heavy lines of appropriate length to indicate the percentage of farms under irrigation. Regardless of State boundaries, draw lines to indicate what you infer to be areas showing the following conditions: (1) over 80 per cent of farms under irrigation; (2) 20–80 per cent; (3) 1–20 per cent; (4) less than 1 per cent. In making your map use Figs. 31 and 101.

2. In the budget estimated for 1915–1916 for India, a total expenditure of over £83,000,000 was planned. Of this £1,000,000 was set aside for famine relief and almost £4,000,000 for irrigation. In the estimated expenditure for Canada these items are not listed. Explain these facts by reference to the physical geography. Find similar figures for the United States and discuss their meaning.

3. The French recently advanced a project for great irrigation works in the upper French Congo which, it was claimed, would make the region a second Egypt. Make maps to show the rainfall, mountain, and river systems, and natural vegetation of the two countries in order to test the truth of this contention. Write an account of French Nigeria from this point of view, using your maps as illustrations.

4. The possibility of irrigating Egypt is largely due to the relief of Africa. Find two regions in the Southern Hemisphere which have a rainfall and natural vegetation comparable to those of Egypt. Examine how far it is possible to increase their fertility by irrigation and the part played by the relief in such a project.

5. Compare the rainfall of the United States with the irrigation map of the Western States. Choose four important irrigated areas in different States. Find out the distribution of rainfall in summer and winter. Show the relation of this to irrigation. Show also what other conditions make irrigation necessary or profitable. In which area would you expect the water supply to be most steady and abundant? Why?

# CHAPTER XVIII

## MAN'S WORK IN REGIONS OF CYCLONIC STORMS

**The Location of the Regions of Cyclonic Storms.**—In our survey of human activities we have now come to the most advanced parts of the world. These are the regions of cyclonic storms. They form two irregular belts. The southern belt includes only the southern part of South America and a small bit of southeastern Australia together with New Zealand. The northern belt crosses North America and Eurasia at their widest parts. In the western hemisphere it includes most of the United States and southern Canada, and in the eastern, most of Europe. The only parts not included are southern Spain, southern Italy, the Balkan Peninsula, and the dry region around the Caspian Sea together with the districts bordering the Arctic. In Asia the northern cyclonic belt extends into Siberia, where it is followed by the line of the Siberian Railroad, but the cold tundra-like regions on the north and the great deserts on the south compress it to such narrow limits that in the far interior it almost disappears. On the eastern coast of Asia, however, it reappears and broadens to include Japan.

**Characteristics of a Cyclonic Climate.**—Climatically the cyclonic belts have three chief characteristics: (1) Rain falls in moderate abundance at all seasons. (2) The weather is subject to marked changes every few days. These two characteristics are both due to the frequent passage of cyclones followed by anti-cyclones. (3) The seasons are strongly pronounced. The winters are cool or more often cold, and the summers warm or hot. Thus the regions of cyclonic storms are particularly favorable not only to agriculture because of the even distribution of rainfall throughout the year, but to man because of variations of weather both from day to day and from season to season. In the course of a year they experience samples of the climate of almost every part of the world.

**The Natural Vegetation of Cyclonic Regions.**—The cyclonic regions, in a state of nature, are usually clothed with deciduous forests, but also include the southern fringes of the great coniferous forests of the northern hemisphere. Some parts also consist of grasslands like the prairies. The deciduous forests comprise broad-leaved trees such as the birch, beech, ash, maple, oak, elm, willow, and poplar. Pines however, are frequently mixed with them. Such forests prevail in large parts of the eastern United States, England, France, Germany, and neighboring parts of Europe. The variety of the trees is in accord with the variety of crops which can be raised in the cyclonic regions.

The coniferous forests included in the cyclonic area occupy southern Canada, southern Scandinavia, and central Russia together with certain mountainous sections like Japan.

The grasslands lie in the interior of North America and Eurasia in the same latitude as the deciduous forests. They occur in places where, although rain falls at all seasons, continental influences cause it to be less abundant in winter than in summer. Thus while the American prairies, the plain of Hungary, and parts of the plains of Russia and Siberia have a cyclonic climate favorable for man and agriculture, they are not favorable for trees.

**How Cyclonic Regions Dominate Civilization.**—Although the regions where cyclonic storms are highly developed occupy only a tenth of the total land surface of the earth, they support a population of 600,000,000 and include the world's most progressive countries, as appears in Fig. 85. This is clear from the following list:

COUNTRIES INCLUDED IN AREA OF CYCLONIC STORMS

A. Europe (about 400,000,000 people)
- British Isles
- France
- Belgium
- Holland
- Denmark
- Southern Norway
- Southern Sweden
- Southern Finland
- Germany
- Switzerland
- Northern Spain
- Northern Italy
- Austria
- Poland
- Czechoslovakia
- Jugoslavia
- Bulgaria
- Roumania
- Western, Southern, and Central Russia

B. North America (about 100,000,000 people)
- United States
- Southern Canada

C. Asia (about 80,000,000 people)
- Japan
- West central Siberia

D. South America (about 10,000,000 people)
- Central Argentina
- Central Chile

E. Australia (about 5,000,000 people)
- Southeastern Australia
- New Zealand

This list includes the only important parts of the world where manufacturing and commerce as well as agriculture are carried on extensively. The inhabitants of the cyclonic regions are so energetic that they raise far more food then those of other regions; they mine most of the minerals, and prepare most of the raw materials. They invent and run the world's machinery, construct its great power plants, and prepare its manufactured goods. They also build railroads both at home and abroad; they engineer the great tunnels, bridges, and harbor works in every land; and sail their ships to every corner of the seven seas. Moreover, they govern the world, for among them they rule practically all of Africa, and all of Asia except China, while elsewhere their voice is dominant through the League of Nations. All these activities put them in the forefront of civilization.

**The World's Chief Products.**—It is most extraordinary to see how large a part of the articles that enter into the world's commerce come from countries where cyclonic storms prevail. This is true of food and raw materials as well as of manufactured goods. Here is a table of 37 of the most important products aside from manufactures. The approximate value of the new material produced each year is given in the table, but it must be understood that this is only a rough estimate, since figures are not available for all parts of the world and prices vary constantly. Nevertheless the figures give a good idea of the relative importance of different products, and of their enormous production. For wood and millet, however, no data are available even for an estimate, but they have been given places that indicate their probable importance.

THE WORLD'S CHIEF PRODUCTS

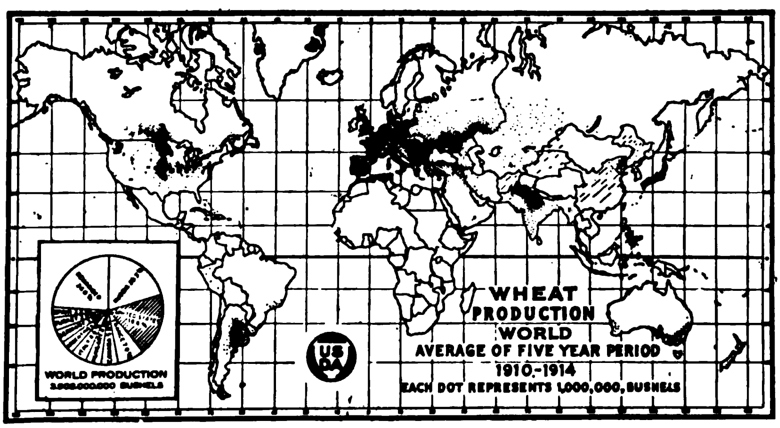
| | |
|---|---|
| A. *Food Products* | |
| 1. Rice | $8,000,000,000 |
| 2. Wheat** | 5,000,000,000 |
| 3. Potatoes** | 5,000,000,000 |
| 4. Dairy products** | 5,000,000,000 |
| 5. Corn* | 3,500,000,000 |
| 6. Sheep and goats* | 3,000,000,000 |
| 7. Millet | ........... |
| 8. Cattle (excluding hides)* | 2,500,000,000 |
| 9. Swine** | 2,500,000,000 |
| 10. Poultry and eggs** | 2,500,000,000 |
| 11. Oats** | 2,500,000,000 |
| 12. Vegetables (excluding potatoes) | ........... |
| 13. Rye** | 2,000,000,000 |
| 14. Sugar* | 2,000,000,000 |
| 15. Beans | 1,500,000,000 |
| 16. Barley* | 1,500,000,000 |
| 17. Coffee | 600,000,000 |
| 18. Tobacco | 400,000,000 |
| B. *Raw Materials* | |
| 1. Coal** | 6,000,000,000 |
| 2. Cotton | 2,000,000,000 |
| 3. Iron** | 2,000,000,000 |
| 4. Petroleum* | 2,000,000,000 |

| | |
|---|---|
| 5. Wood* | ........... |
| 6. Wool* | $1,500,000,000 |
| 7. Hides* | 1,500,000,000 |
| 8. Copper* | 500,000,000 |
| 9. Gold | 400,000,000 |
| 10. Rubber | 400,000,000 |
| 11. Raw silk** | 300,000,000 |
| 12. Flaxseed | 300,000,000 |
| 13. Flax fiber | 250,000,000 |
| 14. Lead** | 150,000,000 |
| 15. Silver* | 140,000,000 |
| 16. Tin | 130,000,000 |
| 17. Zinc** | 120,000,000 |
| C. *Other Products* | |
| 1. Hay | 3,500,000,000 |
| 2. Horses | 1,500,000,000 |

In the table of the world's chief products two stars have been added to each product which comes mainly from cyclonic regions; and one to those derived in about equal measure from cyclonic and non-cyclonic regions. Notice that of the 23 products with a value of a billion dollars or more per year 11 come mainly from cyclonic regions, namely, wheat, potatoes, dairy products, oats, rye, barley, swine, coal, iron, hay, and horses. Eight others corn, sheep, poultry, cattle, sugar, wood, hides, wool, and copper, come partly from such regions. This leaves only three, rice, millet, and cotton, which are not produced in vast quantities in the cyclonic regions. How poor the non-cyclonic regions seem with only three great products of their own and part of nine others, although they occupy nine-tenths of the land area of the globe. Contrast this with the 11 great products of the cyclonic regions, to which must be added part of eight others and practically all of the world's machinery, textile products, and other manufactures. Although the cyclonic regions include only about a tenth of all the lands and two-fifths of all the world's people, their products are worth three times as much as those of all the rest of the world. In other words, each individual in the cyclonic regions produces at least five or six times as much as the average individual in the other parts of the world.

The great supremacy of the cyclonic regions is due primarily to the inherited ability of the people and to the stimulating climate, as explained in a previous chapter. It is also due in part to three other causes: (1) a climate more favorable than any other to crops which are highly nourishing and can be kept a long time; (2) climate and vegetation favorable to the most valuable of all domestic animals; and (3) great supplies of coal and iron which are easily available.

**Food Products of Cyclonic Regions: Wheat.**—In order to gain a clear idea of the conditions which make cyclonic regions so favorable to the production of food, let us examine some of the chief food products and study their distribution as shown on maps. Most people recognize that wheat is the most valuable of all food-stuffs, but not till wheat became scarce during the Great War did the world realize how much we lean on this staff of life. Then England, France, Italy, and other countries besought the United States to send wheat, more wheat, and still more wheat. For a time it was more valuable than guns and ammunition; it was the one thing that could not by any possibility be spared if the war for self-government was to be fought to a finish. So the United States had to limit its own consumption, and




*Courtesy of U. S. Department of Agriculture.*

FIG. 104.—The World's Production of Wheat.

pay bounties to the farmers to enable them to raise larger quantities of this most valuable of food products.

The great value of wheat lies in the fact that (1) it is highly nutritious, so that even if people have no other food they can live on it a long time. In this respect it is much superior to rice, its nearest rival in importance. (2) It is economically produced. From seed time until it is barreled up as flour all the processes can be performed by machinery. (3) Wheat can be kept a long time either in the form of the whole grain or flour. In this it is far superior to corn, which would otherwise have an advantage because the yield per acre is so large.

Let us now turn to Fig. 104 and see how the production of wheat is related to the cyclonic areas.

Although western Europe is one of the most densely populated parts of the world, it is also the greatest center of wheat production. The cyclonic area of the United States and Canada comes second, and that of central Argentina holds high rank. Subtropical and monsoon countries, especially the Mediterranean lands, and northern India produce a good deal, but their production is not a sixth as great as that of the cyclonic regions. In equatorial regions the warm moist climate forbids the growth of wheat. Even in the northern cyclonic regions large areas produce only a little because they are too moist in summer or else too snowy in winter. Wheat wants a region with cool

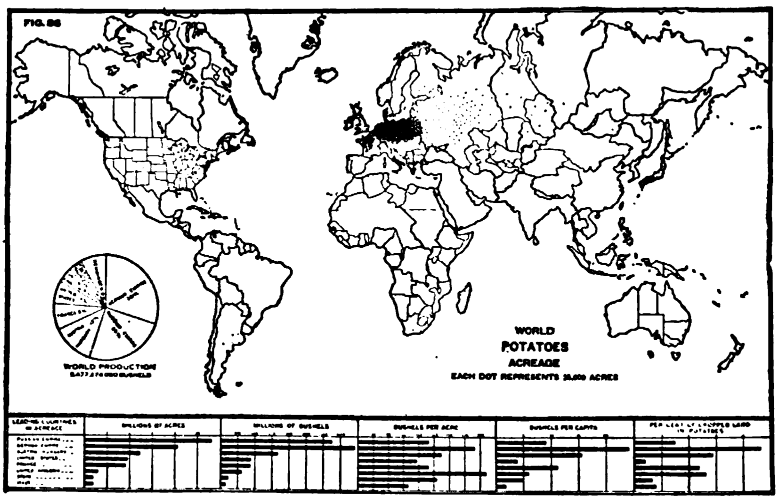


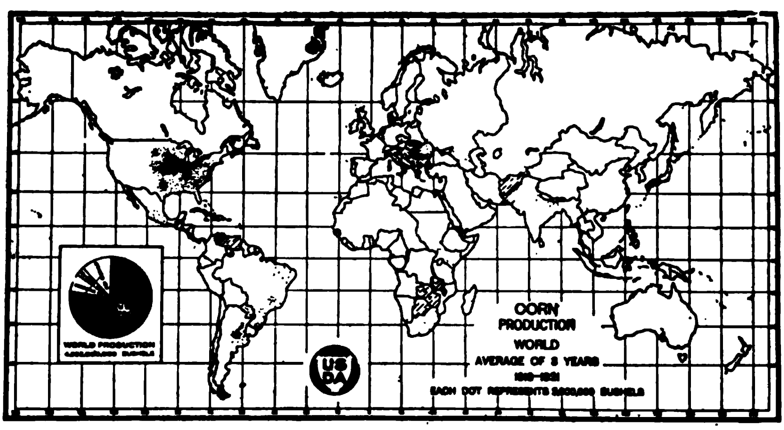

FIG. 105.—Distribution of Potatoes.
*From Geography of the World's Agriculture, by V. C. Finch and O. E. Baker.*

winters, and plenty of moisture in the fall and spring, but not too much in summer. It is naturally a product of subtropical regions, where its bearded wild ancestor is still known. Nevertheless through the ingenuity of man it has now become mainly a product of the regions of cyclonic storms. Contrast its distribution with that of rice, Fig. 95, which is a typical product of tropical and especially monsoon regions.

**Potatoes.**—Potatoes, Fig. 105, are a cyclonic crop even more strikingly than wheat. Practically none are raised outside the cyclonic regions. Western Europe seems almost to be one great potato patch. We think that we raise a great many potatoes, but Europe raises 90 per cent of the world crop. In northern Europe this crop occupies much the same pre-eminent position as the rice crop in the

Orient and corn in the corn belt of the United States. We speak of *Irish* potatoes because the damp cool climate causes them to be the chief food in Ireland. The Irish crop, however, is a small matter compared with that of Germany, which is four times as large as that of the whole United States. This explains how it happened that during the Great War the saving of the waste caused by peeling raw potatoes was an important means of enabling the Germans to get food enough when their outside supplies were cut off. It is strange that the potato which originated in the tropical highlands of America should now be raised chiefly in the cyclonic regions of Europe.

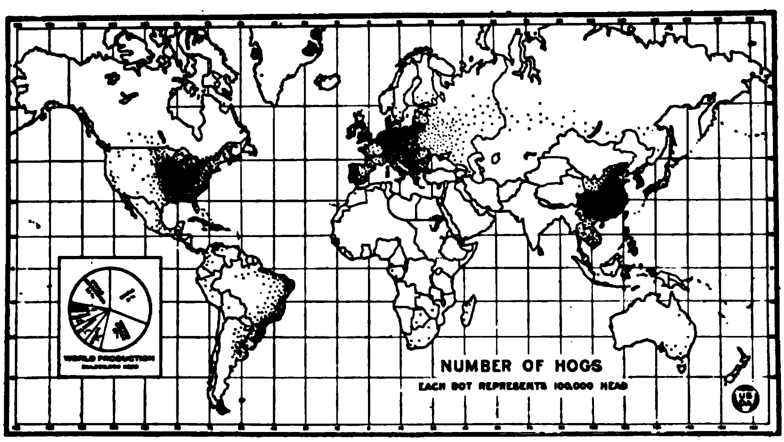
**Corn.**—The map of corn, Fig. 106, shows an interesting contrast to that of potatoes. The two crops both grow most abundantly in




*Courtesy of U. S. Department of Agriculture.*

Fig. 106.—The World's Production of Corn.

the United States and Europe, but not in the same places. Corn on the whole grows somewhat equatorward of potatoes. It needs hot, sunny weather with abundant showers. In the United States these conditions occur on the southeastern flank of the cyclonic belt from Iowa, Illinois, and Ohio southeastward. In Europe the corn belt lies similarly on the southeastern flank of the storm belt, so that it falls in Italy, Austria, and Roumania. In South America, again, the main corn area in Argentine lies in a similar position, which means that it is located on the northeast or equatorward margin of the storm belt. Corn likewise grows outside of the cyclonic belt in places like Mexico, and in Egypt and India where it is irrigated. Three-fourths of the world's crop, however, grows in the United States, while the production in other American countries, especially Mexico and Argentine, equals that of the rest of the world. In this case, quite unlike the potato, a plant which is native to America is still cultivated chiefly in this continent. Nevertheless, although corn originated in tropical regions and was mainly cultivated there for many centuries, the superior energy of the people of the cyclonic belt has now caused it to be chiefly a crop of cyclonic areas. Corn, potatoes, and wheat all illustrate the striking fact that if a plant is unusually good for food the people of cyclonic regions take it in hand and not only improve it, but produce new varieties which will grow where these people want them. That is one great reason why so large a number of the world's chief food crops grow in cyclonic regions.




*Courtesy of U. S. Department of Agriculture.*

Fig. 107.—World Distribution of Hogs.

**Oats, Rye, and Barley.**—Of the three cereals which stand next to corn in importance, both oats and barley are naturally products of the cyclonic regions of Europe where they now chiefly occur. Rye came originally from the mountainous parts of the subtropical region around the Mediterranean and in western Asia. Oats, Fig. 108, grow in much the same cyclonic regions as potatoes, but are more widely distributed. They are equally good for men and horses, but unfortunately are so bulky that they cannot bear the cost of long transportation. Hence they are largely consumed close to where they grow and are used for horses more then for men. Rye grows in much the same places as potatoes and oats, that is, farther north than wheat, but within the limits of the cyclonic regions. About 96 per cent of the world's entire crop is raised in Europe, especially Belgium, Germany, and central Russia. It occupies the poorest soils of cyclonic regions as well as the poorest climates, and is eaten by the poorest people. Barley grows in essentially the same places as wheat, but has a shorter growing season and can endure greater aridity and lower temperature. Hence barley increases in relative importance on the edges of the wheat regions, such as North Africa and Turkey, where the climate is dry, and in Great Britain and Scandinavia, where the climate is cool.

**Swine.**—Swine, Fig. 107, illustrate the way in which the people of the cyclonic areas take animals, as well as plants, from other parts of

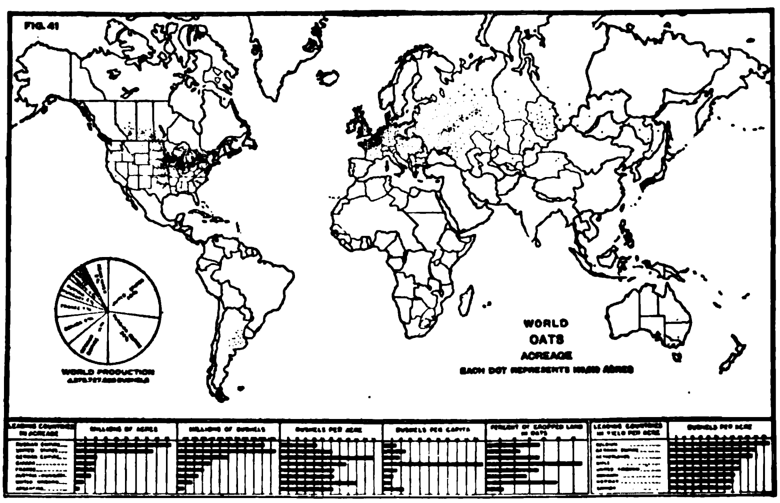



FIG. 108.—Distribution of Oats.

*From Geography of the World's Agriculture, by V. C. Finch and O. E. Baker.*

the world and make them much more useful than in their native homes. Wild pigs of one kind or another are found in most parts of Europe, Asia, and Africa, while their near relatives, the peccaries, occur from New Mexico southward to Patagonia. The wild pigs find it easiest to get a living in the warmer regions, and domestic pigs can be kept in such regions with the minimum amount of work. Yet to-day the central United States, where there have been no wild pigs for millions of years, has more swine in proportion to the population than any country except Denmark. Other cyclonic countries like Germany, Austria, Hungary, and Argentina also have a relatively large number. Where tropical or Oriental countries have many pigs, as in Venezuela, Colombia, and China, it generally means that they have very few other domestic animals, and that they can keep the pigs with almost no trouble. In Mohammedan countries, on the contrary, the use of swine for food is forbidden by religion, and hence as the map shows, the familiar pig stye is absent in those lands.

Americans often suppose that pigs everywhere live on corn. This is true in America, as may be seen by comparing Figs. 106 and 107. In the more progressive countries of Europe, however, the pigs are fed on barley, potatoes, skimmed milk and root crops, while in regions like Servia they are often turned out in the oak forests to fatten on acorns. In Germany before the war about 600,000,000 bushels of potatoes, or one and a half times the ordinary crop of the United

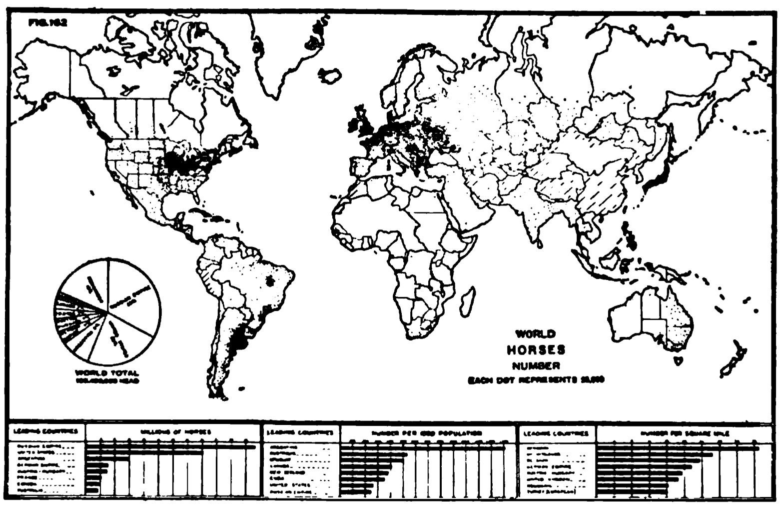



FIG. 109.—Distribution of Horses.
*From Geography of the World's Agriculture, by V. C. Finch and O. E. Baker.*

States, were fed to the pigs each year. Just as the American farmers of the cyclonic belt raise millions of bushels of corn in order that they may have plenty of pork, ham, and bacon to eat and to sell, so the Germans raise potatoes, while the Danes raise barley or use the skimmed milk of their cattle after the cream has been taken off for butter.

**Cattle.**—The distribution of cattle, Fig. 91, affords still another interesting illustration of how differently people utilize their resources. The map shows four chief cattle areas: two are the great cyclonic areas of the United States and western Europe which stand out so prominently in many other lines; a third is on the equatorial border of the southern cyclonic region in the American countries of Uruguay and Argentina: and the fourth is in tropical Java and India.

**Why the Cattle of India Yield so Small a Return.**—Let us begin with India and see how little the people exert themselves in cattle farming and how little they get from it. Although India has an enormous number of cattle, it has few in proportion to the population. A score of other countries have relatively more. The Indian cattle are used almost entirely for plowing or for drawing carts. Few are used for food. Long ago the number of animals in India was so small that there was great difficulty in getting enough for plowing. Hence it was not considered right to kill them, and finally this became a strict religious prohibition which no Hindu dare break even in the direst need. Only Mohammedans kill and eat them, and most of the cattle therefore live on and on and die of old age. Thus a large percentage of those in India are too old to be of much value except for manure. Most of the cows are not even used for milk. This is partly because the grass is poor. If the cows are milked the yield is so scanty that the missionaries call them "tea cup" cows. Moreover, the people have so little initiative and energy that they make no effort to see that the animals are better fed, and that the breeds are improved. Even when the cattle of India die many of the hides are not used. Thus the cattle of India yield only a slight return, but this is as much as is warranted by the slight care given them.

**Why the Cattle of South America Yield a Moderate Return.**—The cattle of southern Brazil, Uruguay, and especially northern Argentina, are of greater use than those of India. To a certain extent they are employed as draft animals, although horses also do this work, but the main use is for food and hides. As soon as they are large enough they are slaughtered for export. Rarely, however, are they used for milk. This is partly because, although their natural food is better than in India so that they would give more milk if properly cared for, the pampas grass is not so good as that of cooler regions. Still more important is the fact that the people believe that it does not pay to care for milch cows, but this is only half true. On many a cattle ranch where there are hundreds of cows that might be milked, high prices are paid for condensed milk brought from the United States. In the more cyclonic parts of Argentina, however, conditions are beginning to be like those in the United States, and butter and casein are exported.

**Why the Cattle of Cyclonic Regions Yield a Large Return.**—In the cyclonic regions of western Europe and the United States cattle are far more useful than in any other climatic zone. They do not do much plowing or hauling, to be sure, since they are too slow for that. As a source of food, however, they are vastly more important than elsewhere. Vast numbers are kept as milch cows, and are tended so carefully that farmers are sometimes accused of looking out for their cows better than their children. Such care is well rewarded by abundant supplies of milk, cream, butter, and cheese. Some of the animals that are not needed for milk are killed as calves, but more are allowed to grow up. None of those meant primarily for food, however, are allowed to grow old, but all are fattened and killed while their meat is still tender. Not only are the hides of such animals used, as in parts of India, and the hides, hair, and meat as in South America, but the bones, horns, blood, and internal organs are all used for fertilizer, glue, and other products. Such great effort in taking care of the cattle for milk, manure, meat, fertilizer, and other purposes, and in improving the breeds, is due to the energy of the people of cyclonic regions, but these regions also have other advantages. The cattle raiser in places like Wisconsin and Holland, for example, is favored with the finest kind of grass and with great markets close at hand. Thus in cattle raising, as in many other respects, the cyclonic regions are blessed with conditions that are favorable for plants and animals as well as for man.

**How the Cyclonic Regions Compare with the Rest of the World in Producing Raw Materials.**—In the table of world products, the chief raw materials, as distinguished from foodstuffs and fuels, are as follows: (1) cotton; (2) iron; (3) wood; (4) hides; (5) wool; (6) copper; (7) rubber; (8) silk; (9) lead; (10) zinc; (11) tin. These materials fall into two great classes: (*a*) five mineral products the occurrence of which has nothing to do with climate, and which are as likely to occur in one zone as another; (*b*) six plant or animal products which can be raised only in certain regions determined by climate. Let us see where each class comes from and where it is used.

**Where the Metals are Mined and Used.**—Among the five most useful metals, four, namely, iron, copper, lead, and zinc, are so widely distributed that each climatic zone appears to have an abundant supply stored away among its mountains. Yet look at Figs. 53 to 58 and see where the world's supply comes from. All are produced overwhelmingly in cyclonic regions. Iron, the ores of which are by far the most universally distributed over the earth's surface, is the one produced most exclusively in cyclonic regions. The extraordinary leadership of the cyclonic regions is vividly brought out by comparing Fig. 53, showing where iron ores are known to exist in large quantities, with Fig. 54 showing where iron is actually mined.

Tin alone among the five most useful metals occurs almost wholly in one climatic zone, for it is produced mainly in Malaysia and Bolivia. Most of the tin, however, is now mined by European methods, and practically all of the product is shipped to cyclonic regions. With most of the other metals, as well as with non-metallic mineral products like brickclay, similar conditions prevail. If the distribution of the ores is limited, as in the case of gold, silver, and mercury, the mines in other regions are usually run by people from the cyclonic areas. If the minerals are widely distributed in all zones, as are aluminum ores, pottery clays, and roadbuilding stones, they are exploited pre-eminently in the cyclonic areas. Because of their greater energy the people of cyclonic regions not only have developed their own mineral resources with almost reckless rapidity, but have reached out and procured for their own use the best of all that occurs elsewhere.

**Where the Vegetable and Animal Raw Materials are Produced and Used.**—The six most useful non-metallic raw materials, as we have seen, are cotton, wood, hides, wool, rubber, and silk. Unlike the metals, these cannot possibly be produced in most parts of the world. Cotton is a product of monsoon and subtropical climates. Good wood is common in four of the world's main regions of climate and vegetation, namely the equatorial rain forest, the tropical jungle, the deciduous forest, and the coniferous forest. A scattered supply, moreover, is found in tropical scrub, in savannas, in subtropical dry forests, and in the irrigated parts of deserts. Nevertheless far the best kinds of wood for ordinary use are the larger conifers especially the pines, which are both easily worked and durable. These grow best on the southern borders of the great coniferous forests and in scattered areas on mountains or in special soils farther south. Hence they are largely a cyclonic product. North of the cyclonic regions the coniferous forest is relatively stunted and is valuable chiefly for pulp wood for paper.

Wool and hides both come from animals which naturally live in the grasslands of the prairies, steppes, and savannas, and hence are adapted to many climatic regions. Rubber is the only genuinely tropical article on our list, while silk, like cotton, belongs naturally to monsoon and subtropical climates. Thus no one of the six most useful non-metallic raw materials is primarily a product of cyclonic regions, but wood, wool, and hides can be produced there as well as anywhere. As a matter of fact, however, they are produced in those regions far in excess of all other regions. How true this is may be seen from Figs. 96 and 91, since wool and hides naturally come from the places where sheep and cattle are most numerous. The same is true of silk, the other animal product on our list. We think of it as a product of warm regions, but the vast bulk of the world's silk supply comes from two cyclonic regions, Japan and northern Italy. The people of these cyclonic regions have taken silk worms, just as others have taken cattle and sheep, and have developed types that thrive in climates somewhat cooler or moistër than those where the animals originally lived.

Rubber and cotton illustrate the dominance of the cyclonic regions quite as forcibly as do any other products. Rubber does this in the same way as tin, for although it is a purely tropical product, it is practically all exported to a few cyclonic countries and there manufactured. The United States consumes over half the world's rubber. Cotton illustrates the matter in much the same way. Fig. 98 shows where the world's cotton crop is grown. It is clearly limited to fairly warm regions. But compare this with Fig. 44 which shows where the cotton is woven into cloth. Evidently the greater part of the cotton crop is carried to cyclonic regions and there manufactured.

**Why Crops Improve as They are Moved toward Cyclonic Regions.**—Cotton shows the effect of the energy of the people of cyclonic regions in still another way. The average yield of the crop per acre in the United States displays a general tendency to increase toward the north. Near the northern limit in southern Missouri and Virginia the yield per acre is about twice as great as in Florida and Louisiana. Like many other crops, cotton naturally grows best in about the middle of its geographical range. We see this in all wild plants. The best pine trees, for example, grow neither in the far north nor the far south; the holly is a little bush in New England, it becomes a great tree in the Southern States, where it thrives best; while still farther south it again diminishes in vigor. So, too, with thousands of other wild plants, both great and small. Yet among cultivated plants derived originally from warmer climes, not only cotton, but corn, wheat, potatoes, oranges, grape fruit, and others grow best at their northern limit. In other words, when these crops are gradually moved toward the regions where man is most competent their productivity and quality improve because of the care given them, although naturally they would not thrive in their new homes.

**The Supremacy of the Cyclonic Regions in Transportation.**—Figs. 109 and 33 illustrate the concentration of horses and of railways in the cyclonic regions. How far is this due to other factors than climate? Plains, especially grasslands, certainly have an effect on the distribution of horses, for there are more horses in the grassy plains of the central United States, eastern Argentine, and southwestern Russia than in the neighboring regions. But in the grassy plains of the non-cyclonic regions of the Orinoco, and the Sudan, there are practically none. So, too, railroads are numerous throughout the plains of cyclonic regions, but are absent in the still greater plains of the Amazon Basin, northern Canada, northern Siberia, and Arabia. The density of the population also has an effect on the distribution of both horses and railways, but how important is this? Compare Figs. 109 and 33 with Fig. 37, showing the distribution of population. China, Java, and India are among the blackest areas on the population map, yet there is only one mile of railway for every 30 square miles of territory in Java, 50 in India, and 220 in China, while there is a mile of railway for every 11 square miles in the United States, 8 in France, 6 in Holland, and 5 in Great Britain. Moreover, both Java and India would have a railway net even less dense than that of China if they had not received railway systems from their Dutch and English rulers. Thus it appears that while relief, vegetation, and density of population all have some effect on the development of means of transportation, the main effect is due to the cyclonic climate. In cyclonic regions the people have plenty of work for horses and plenty of freight for railways, and they also have the ability and energy to improve the breeds of horses and to invent and build railways.

If we had maps showing the world distribution of good roads, automobiles, trolley lines. or airplanes, they would all show the same pre-eminence of the cyclonic regions.

**Where the World's Manufacturing is Done.**—If a country is to be prominent in manufacturing, there must be (1) coal for power, (2) iron for machinery, but much the most important requisite is (3) inventive energetic people to manage the factories and run the machinery. We have already seen that though iron ore is found in practically all parts of the world, it is extensively mined and smelted only in cyclonic regions. Coal follows the same rule. Although coal is less abundant in tropical countries than elsewhere, it is found in all the climatic zones, as appears in Fig. 60. Some of the finest of all deposits are in China and Indo-China. Yet almost all the mining is done in the cyclonic regions, as is clearly evident from Fig. 61. What little coal mining is carried on elsewhere, as in Spitzbergen, is often done in order to bring more coal to the cyclonic regions. As a rule, however, the amount of coal mining outside of cyclonic regions is so small that coal is carried in large quantities from the United States and especially England to remote parts of the earth like China, even when those regions have supplies of their own which are not yet developed.

The presence of energetic people, as we have seen, is due largely to the stimulating effect of the varied climate of cyclonic regions. Let us

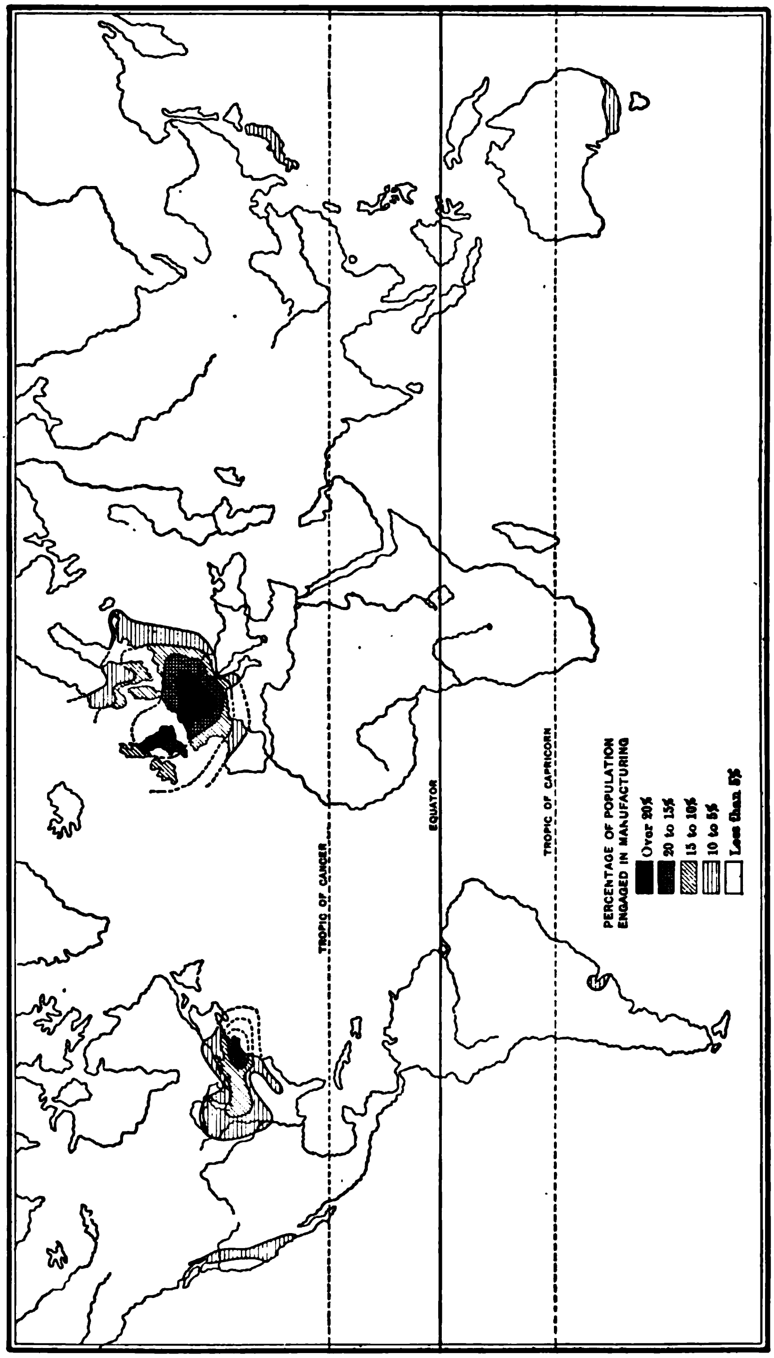



FIG. 110.—Percentage of Population Engaged in Manufacturing.

see how this climatic condition, with the help of coal and iron, has caused the world's manufacturing to be distributed. Fig. 110 shows the percentage of the inhabitants who are engaged in manufacturing in various regions. The darker the shading the greater the percentage. Notice that there are two prominent dark areas, one in the eastern United States, and the other in northwestern Europe. Each is in the heart of one of the world's two main cyclonic regions. Beyond their limits the amount of manufacturing rapidly diminishes, so that large parts of the map are unshaded. The only other places where the shading again becomes noticeable are a few smaller cyclonic areas like Japan.

**Why Cyclonic Countries are the World's Chief Markets.**—Strange as it may seem, manufacturing countries buy from one another far

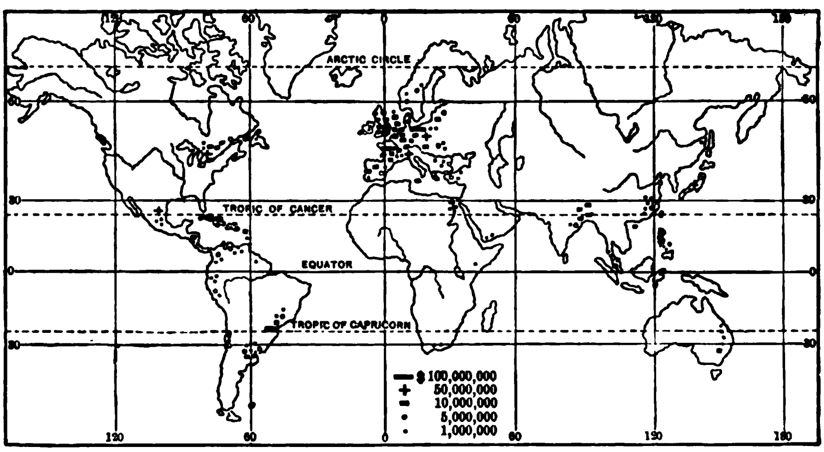



FIG. 111.—Purchases of the United States Abroad.

more than from other climatic regions, and their sales are made in the same regions. England, for example, does ten or twelve times as much business with the 100,000,000 people of the United States as with more than three times as many in China. Even with the 300,000,000 people of its own chief colony in India it does only about as much business as with the 40,000,000 people of France. The purchases and sales of the United States in foreign countries are shown in Figs. 111 and 112. If the trade of the United States with the 300,000,000 people in the leading nations of cyclonic regions were cut off, two-thirds of our commerce would be gone in spite of the fact that there would still be 1,200,000,000 people with whom to trade.

Business men continually urge the expansion of our trade with China, Siberia, and especially Latin America. They are right in theory, for those countries, particularly the ones that are tropical, produce many useful products which our own country cannot furnish. It is far more important for us as a nation to be able to purchase plenty of tropical rubber, quinine, coffee, and tin, which we cannot possibly produce in our own country, than to be able to buy European cloth, machinery, or dyes, which are not very different from our own, and which we could perfectly well make ourselves. Yet in spite of this it is far more difficult to add a billion dollars to our trade with tropical America than to add the same sum to our trade with cyclonic Europe. The reason is largely the difference in energy. The tropical people do not exert themselves to produce goods that we want, nor do they earn enough to be able to buy large quantities of the goods that we

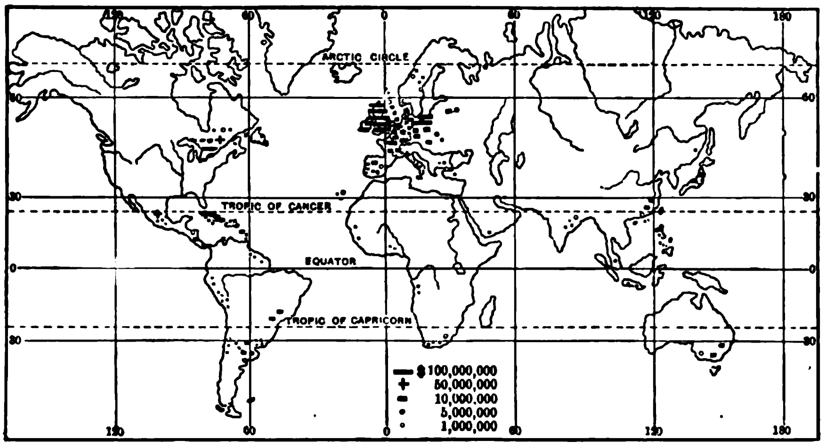



FIG. 112.—Sales of the United States Abroad.

make, no matter how attractive such goods may be. Hence most of the world's trade, as well as most of its other activity, centers in the cyclonic regions.

**How the Cyclonic Regions Lead the World.**—The people of the cyclonic regions rank so far above those of other parts of the world that they are the natural leaders. For instance, the form of democratic government which was worked out in France and England, but which was first really tried in the United States, is the form which every country in the world is gradually trying to adopt. The constitutions of all the South American countries as well as of China are directly modeled on that of the United States, while those of other countries have been greatly influenced by it. Again the inventions of cyclonic regions, especially the United States and England, have led the way to the use of machinery wherever the steam engine, telegraph, and such devices as the sewing machine have gone. So, too, the science and literature written in English, French, and German are translated into other languages and serve as models in every part of the world. In the same way the people of Asia look to Japan as the leader who is showing them how to put themselves on an equality with the countries inhabited by the white race. In art, music, philosophy, and other higher elements of civilization the energy of the cyclonic regions likewise makes them the leaders of the world.

## QUESTIONS, EXERCISES AND PROBLEMS

1. A. The Abstract of the United States Census gives a table of illiteracy among native whites. On an outline map of the United States insert the figures there given and draw smoothly curved lines at intervals of 5, 10, 15, etc. Shade the map so that the best areas will be dark and the worst light. What kind of relation do you detect between your map and Figs. 37, 85, 86, 104, 109, 110? Explain.

   B. Draw a similar map of illiteracy among colored people. How far does this resemble the map of illiteracy among native whites? Why?

2. The following table shows the average annual death rate in Europe for 6 to 10 years immediately before the Great War. Except where enclosed in parentheses the figures have been corrected according to a "standard population," that is, allowance has been made for the proportion of children, old people, and so on. From the figures make a map in the same way as in the preceding exercise, drawing your lines at death rates of 14, 17 and 22. Compare your map with Figs. 29, 38, 61, 81, 85, 89, 105 and 112. Explain whatever relationships you detect, and state your conclusions as to the connection between health and each of the other conditions illustrated in these maps and in those mentioned in Exercise 1.

ANNUAL DEATH RATE IN EUROPE 1904–1913

| | | | | | |
|---|---|---|---|---|---|
| Austria | 21.8 | France | 16.6 | Rumania | (24.7) |
| Belgium | 15.9 | Germany | 18.0 | Russia | (28.9) |
| Bosnia and Herzegovina | (26.7) | Hungary | 24.3 | Scotland | 16.7 |
| Bulgaria | 22.4 | Ireland | 15.1 | Serbia | 23.1 |
| Denmark | 12.4 | Italy | 18.9 | Spain | (22.8) |
| England | 15.4 | Netherlands | 13.5 | Sweden | 12.0 |
| Finland | 15.7 | Norway | 11.9 | Switzerland | 15.8 |
| | | Portugal | (20.5) | | |

3. Take one country from each of the groups mentioned below, and in the Statesman's Yearbook, the U. S. Reports on Commerce and Navigation, or the encyclopædia, find figures for its foreign trade: (*a*) Britain, France, Germany, Holland; (*b*) Rumania, Russia, Bulgaria, Egypt; (*c*) Siam, Ecuador, Peru, Belgian Congo; (*d*) Argentina, Chile, Union of South Africa, New Zealand. For each of the countries thus chosen draw maps like Figs. 111 and 112. Write an account of the more notable resemblances and differences among the four maps and of the geographical conditions which give rise to them.

4. Let each member of the class select some one country and find the figures for its trade with each of the other main countries. Combine the imports and exports and form a table, thus·

FOREIGN TRADE OF (COUNTRY CHOSEN BY STUDENT)

| A | B | C | D |
|---|---|---|---|
| Names of other countries. | Total trade with (country chosen by student). (Express this in hundreds of thousands of dollars, pounds, francs, or whatever unit your tables happen to use.) | Total population of other countries in hundreds of thousands. | Trade per capita of other countries with (country chosen by student) i.e., B divided by C. |
| Australia... | ........................ | ................. | .................. |
| Austria etc.. | ........................ | ................. | .................. |

Insert the figures of column D in their proper places on a map of the world. Draw smoothly curved lines to divide the world into about five zones according to the per capita trade of their inhabitants with the country you have chosen. Shade the chosen country black and the other zones with shades proportional to their trade with the chosen country.

Study your own map and three or four others. Write your conclusions as to the effect on foreign trade of (*a*) distance; (*b*) relief; (*c*) waterways; (*d*) soil and minerals, and (*e*) climate.

5. Obtain a list of all the countries that took part in the Great War. On an outline map of the world shade heavily all those that played a really important part in proportion to their population. Shade moderately those that took some part, but did not do a great deal. Shade lightly those that declared war, but took no real part. Compare your map with Figs. 85 and 86. How do you explain the resemblances and differences?

6. For each of the world's chief products, as given in the table near the beginning of this chapter, write a list of from two to five countries where the product in question is produced in especially large quantities in proportion to the population. Use commercial maps in geographies or atlases. On an outline map of the world print the name of the product in each of the countries where it is especially important. Count the number of names in each country and arrange the countries of the world in order according to the number of names. Discuss the five countries that stand highest on your list, and give the geographical reasons for their position. In the same way discuss the five countries that stand lowest.

## CHAPTER XIX

## THE WORLD'S DIET

**What Constitutes a Good Diet.**—The conditions of agriculture and civilization discussed in previous chapters determine the kind of food that people eat. The food has much to do with health and strength. A good diet must contain three main elements—carbohydrates, fats, and proteids. *Carbohydrates* are substances such as starch and sugar, which, like *fats* are composed of carbon, hydrogen, and oxygen. The carbon is slowly burned in our bodies, and thus gives us warmth and energy. *Proteids* are substances such as cheese, meat, and fish, containing nitrogen. They are necessary because without them the body cannot build new tissues and repair its continual waste. An ordinary adult man engaged on ordinary work requires about eighteen ounces of carbohydrates or fats and 4 to 4½ ounces of proteids per day. For children, sick people, or those who are working very hard, the amount is different, but in general the carbohydrates and fats should be four or five times as abundant as the proteids.

In addition to the three main food substances there is need of smaller quantities of salts, vitamines, and the acids of fruits. A good diet should contain not only the right amount of these and of carbohydrates, fats, and proteids, but should vary from day to day so that people may not get tired of it, and may be sure to get all the needed elements. Aside from the prosperous inhabitants of advanced countries, however, the majority of the world's people live largely on a few kinds of food.

**A Table of Food Values.**—The value of the food used in different parts of the world may be judged from the table given below. Column A shows the kind of food; B, C, and D show what percentage of each kind is waste material like (B) skin and bones, (C) water, or (D) mineral matter, such as salt. Column E gives the percentage of actual food materials in the various articles as we buy them in the market. It will be seen that this varies from only 9 per cent in beets which contain much water and a good deal of waste, to 90 per cent in oatmeal and 100 per cent in sugar.

Columns F and G should be considered together. Column F shows how many pounds of a given article would have to be purchased in order to get from it 4½ ounces of proteids, the daily require-

NUTRIENT VALUE OF FOODS

| A. Kind of Food. | B. Percentage of Waste, Such as Bone, Shells, etc. | C. Percentage of Water. | D. Percentage of Mineral Matter. | E. Percentage of Food Material. | F. Pounds of Materials to be bought to get 4½ ounces of Proteid. | G. Pounds of Materials to be bought to get 18 ounces of Carbohydrates (including fat) | H. Index No. Plus = too Much Carbohydrates. Minus = too Little Carbohydrates (i. e. too Much Proteid). |
|---|---|---|---|---|---|---|---|
| *Animal Products.* | | | | | | | |
| Fish (Fresh Cod) | 30 | 58 | 1 | 11 | 2.5 | 564.0 | −226.0 |
| (Fresh Mackerel) | 45 | 40 | 1 | 14 | 2.8 | 26.8 | −9.6 |
| Eggs | 11 | 66 | 1 | 22 | 2.1 | 12.2 | −5.8 |
| Veal | 17 | 57 | 1 | 25 | 1.8 | 12.2 | −6.8 |
| Beef | 15 | 53 | 1 | 31 | 1.7 | 7.4 | −4.4 |
| Chicken | 26 | 47 | 1 | 26 | 2.1 | 9.2 | −4.4 |
| Mutton | 15 | 44 | 1 | 40 | 2.0 | 6.8 | −3.4 |
| Pork (Fresh) | 15 | 45 | 1 | 39 | 2.1 | 4.3 | −2.0 |
| Bacon | 8 | 17 | 4 | 71 | 2.5 | 1.8 | +1.4 |
| Cheese | 0 | 34 | 4 | 62 | 1.1 | 3.3 | −3.0 |
| Milk | 0 | 87 | 1 | 12 | 8.5 | 12.5 | −1.5 |
| Butter | 0 | 11 | 3 | 86 | 28.2 | 1.3 | +21.6 |
| *Cereals.* | | | | | | | |
| Oatmeal | 0 | 8 | 2 | 90 | 1.7 | 1.8 | −1.1 |
| Wheat (Graham) | 0 | 11 | 2 | 87 | 2.1 | 1.5 | +1.4 |
| Wheat (White Flour) | 0 | 12 | 1 | 87 | 2.5 | 1.5 | +1.7 |
| Corn Meal | 0 | 13 | 1 | 86 | 3.1 | 1.5 | +2.1 |
| Rice | 0 | 12 | 0* | 88 | 3.5 | 1.4 | +2.5 |
| Rye Flour | 0 | 13 | 1 | 86 | 6.6 | 1.4 | +4.7 |
| Rye Bread | 0 | 36 | 2 | 62 | 3.1 | 2.1 | +1.5 |
| Wheat Bread (Graham) | 0 | 36 | 2 | 62 | 3.2 | 2.1 | +1.5 |
| Wheat Bread (White) | 0 | 35 | 1 | 64 | 3.1 | 2.1 | +1.5 |
| *Vegetables* | | | | | | | |
| Peas (Dried) | 0 | 10 | 3 | 87 | 1.1 | 1.8 | −1.6 |
| Beans (Dried) | 0 | 13 | 4 | 83 | 1.2 | 1.8 | −1.5 |
| Beets | 20 | 70 | 1 | 9 | 21.6 | 14.4 | +1.5 |
| Potatoes | 20 | 63 | 1 | 16 | 15.6 | 7.6 | +2.1 |
| Sweet Potatoes | 20 | 55 | 1 | 24 | 20.1 | 5.0 | +4.0 |
| *Fruits.* | | | | | | | |
| Grapes | 25 | 58 | 0* | 17 | 28.1 | 7.2 | +3.9 |
| Bananas | 35 | 49 | 0* | 15 | 35.2 | 7.7 | +4.6 |
| Apples | 25 | 63 | 1 | 12 | 93.8 | 10.1 | +9.3 |
| *Nuts* | | | | | | | |
| Almonds | 45 | 3 | 1 | 51 | 2.4 | 2.8 | −1.2 |
| Walnuts | 58 | 1 | 1 | 40 | 4.1 | 3.4 | +1.2 |
| Chestnuts | 16 | 38 | 1 | 45 | 5.4 | 2.8 | +1.9 |
| Sugar | 0 | 0 | 0 | 100 | No proteids | 1.1 | |

* Less than half of 1 per cent.

FIG. 113.—An Elephant Cart full of Cocoanuts in Burma.

Food supply and transportation in the tropical jungle.

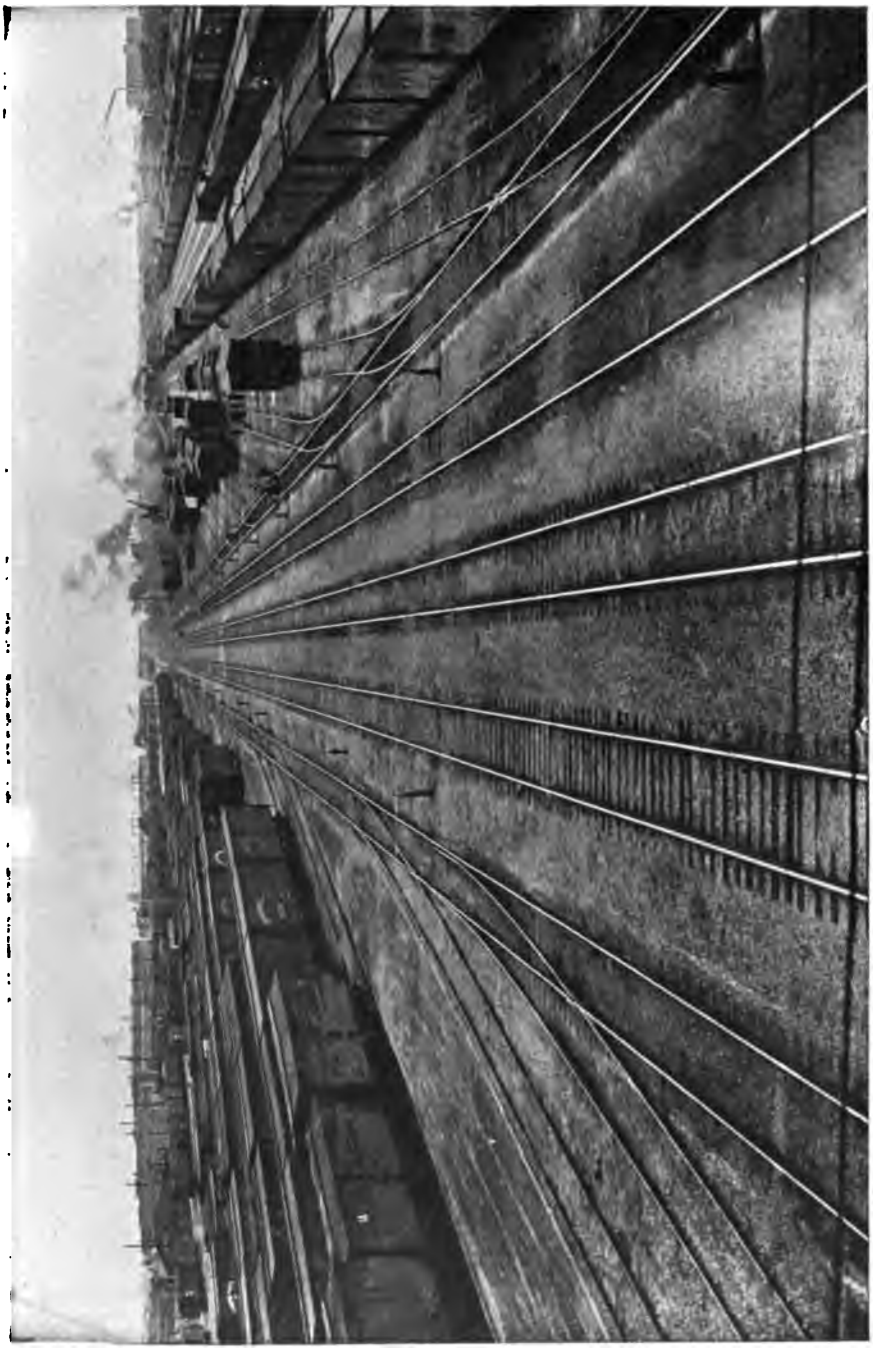


FIG. 114.—A Modern Railroad Yard.

A striking by-product of the junction of rail and water transportation, and an illustration of how food is distributed in cyclonic regions.

ment of an active adult man. Column G shows how many pounds would be needed in order to get the daily requirement of 18 ounces of carbohydrates or fats. In many cases a sufficient supply of both types of food could not be got from a single article without eating an enormous quantity. For instance, suppose a person has to live for a while on nothing but fresh cod, as often happens to the Labrador fisherman. About 2.5 pounds of fresh fish would supply the needed proteids. An ordinary person could easily eat this quantity in a day. Codfish are so lean, however, that 564 pounds would have to be eaten to get enough carbohydrates and fats.

Or suppose a Korean peasant has no supplies except dried beans, would he be as well off as a Turkoman nomad east of the Caspian Sea who has no food except cheese? About 1.2 pounds of dried beans and 1.1 of cheese would be needed for proteids, while 1.8 pounds of beans would have to be eaten to get enough carbonaceous material, and over 3 of cheese. Therefore the Korean with legumes like beans and peas is better off than the nomad with cheese. In order to get enough carbohydrates or fats from cheese the stomach would have to be overloaded with three times as much proteid as it needs and would thus be injured.

In Column H the whole matter is summed up by means of index numbers. A value of 1 means that an article contains the right proportion of proteids and carbonaceous materials. Anything between 1 and 2 forms a fairly good article of diet even by itself. A plus sign means that carbohydrates or fats predominate and a minus sign indicates an excess of proteids. In a good diet the plus articles, carbonaceous, should balance the minus ones with much proteids. Thus beef just about balances sweet potatoes, and chicken balances bananas. On the other hand, a little butter with its great predominance of fat balances a large amount of beans with their slight excess of proteid.

**The Unbalanced Diet of Frigid Regions.**—Let us now use the table as a test of the ordinary diet in various parts of the world. Consider first the meat diet of frigid regions. The Eskimos seem to revel in fat. When they can get it they literally stuff themselves. Sitting on the floor of their dark, smoky huts they seize it with their hands and cram it into their mouths so greedily that their faces shine with fat and their clothing is streaked with it. The Eskimo wants much fat because he needs internal fuel to keep him warm in his far northern climate.

Sometimes the Eskimos are obliged to live for long periods on nothing but fish, which are largely proteid. At such times the poor Eskimo and his family eat and eat, but are not satisfied. Their bodies clamor for carbohydrates, the intestines become deranged, and many Eskimos die from diseases induced in this way. To the disadvantage of too much fish and meat is added the great disadvantage of no cereals, vegetables, or fruits. Accordingly the people of the frigid North cannot be expected to have the endurance and stamina of the white man with his varied and nutritious diet.

**Diet of Equatorial Rain-forests.**—Let us now take a long jump from regions of perpetual cold to those of perpetual heat. The tropical rain-forest is subject to a disadvantage like that of the frigid regions; that is, the people often eat only one kind of food for weeks or even months at a time. For instance, where bananas can be procured they eat them day after day. Yet although they gorge themselves they cannot get enough proteid from that source, for that would require from seventy to eighty bananas a day for each person. Many equatorial people have protruding abdomens either because of the great bulk of the bananas that they have to stuff down in the effort to satisfy their hunger or more probably from the diseases thus induced. The poor quality of the food in time ruins their digestion. Equatorial people also suffer because their meals are not regular. Not only do they eat at any hour when they feel like it, but when they find plenty of food they gorge themselves, and then go hungry for days.

**Diet of Tropical Jungles.**—In the parts of the tropical jungle where agriculture is simplest the food is scarcely better than in the equatorial forest. The crops are such roots as the sweet potato and yam, and such fruits as the cocoanut and bananas. In such a diet starch or sugar predominates so largely that people eat ravenously, but even thus do not get enough proteids. Although an occasional pig, fowl, or goat is eaten, and some fish are caught in the streams, this happens at such rare intervals that much harm is done in the meantime.

Where the jungle people raise corn, rice, or millet the diet becomes better than in jungle regions with more primitive agriculture. Notice in Column H of the table that corn and rice are only about half as starchy as bananas and sweet potatoes. Millet is not quite as good as corn and rice, although it is widely eaten because it can easily be raised in warm places where the rainy season is short. All three grains, however, have the advantage of not containing a great amount of water or other waste materials—only 13 per cent as appears in Column C. Therefore they do not overburden the stomach and cause digestive troubles, as does the more primitive tropical diet. Nevertheless, they contain twice as much starch as is advisable. Moreover, the lack of certain vitamines renders those who eat such a diet liable to certain diseases such as beri-beri. In the majority of well-populated tropical regions meat is usually so scarce and expensive that it forms no appreciable part of the diet, and there is nothing to counteract the starchiness of the other foods. In spite of this the tropical people who raise corn, millet, and especially rice, are not only benefited by the necessity of steady work, as we have seen, but by the fact that their diet is better than that of more primitive people.

**Diet of Monsoon Regions.**—In monsoon regions like China, for example, the commonest food is rice or millet. (See Fig. 95, Rice Map.) Since these grains are starchy, the people make great efforts to satisfy their craving for proteids. Because of the density of the population and the consequent scarcity of animals, even the less expensive meats like pork are too costly for ordinary people except at feasts or other special occasions. That is why the Chinese sometimes eat rats, dogs, and other animals which we despise. Perhaps we should feel differently if our supply of proteids were as limited as that of the Chinese. Fish, however, can be raised without diverting land from the crops needed by man. Hence no people in the world take more pains than the Chinese to catch fish in the sea and rivers, and raise them in ponds. In spite of this the animal food of China is inadequate. Therefore recourse must be had to plants for proteids. As legumes contain more proteids than any other vegetable foods the Chinese raise them in enormous quantities, especially beans. To render them palatable and to avoid monotony they make them into bean flour, bean macaroni, bean oil, bean curd, pickled beans, and *soy*, a hotly spiced sauce. Thus they obtain a fairly good diet, although it still has too much starch and not enough proteids. Moreover, it has not enough fruit, for fruit seems a luxury to the Chinese, although really it is needed to round out a balanced diet.

**Diet of Subtropical Regions.**—Subtropical people are more fortunate than those of monsoon regions. Wheat, their staple crop, is among the best articles of diet, especially if one product has to be used as the main food. It is somewhat starchy, but as the subtropical regions are favorable to domestic animals, especially sheep, there is plenty of meat to supply proteids. Moreover, both fruits and nuts thrive admirably in subtropical countries, especially under irrigation, so that the best kind of diet is available.

The food supply of subtropical regions is favorable not only because it contains a healthful proportion of proteids, carbohydrates and fats, but because it renders such regions less liable to famines than are those that depend on rice or millet with beans or peas. A poor wheat crop is not accompanied by a failure of the supply of proteids. When a dry season causes poor crops in subtropical regions where animals are abundant, the price of meat may even go down for a while. This is because the scarcity of pasture, fodder, and grain makes it impossible for people to keep all their animals. Therefore, many of them are sold for slaughter; thus when the carbohydrate supply is short, the proteid supply tends for a while to increase. In the rice and millet countries the beans and peas are likely to fail at the same time with the cereals, since all depend upon the same rains. The failure of both kinds of food produces correspondingly severe famines.

**Diet of Cyclonic Regions.**—The cyclonic zone is the most favorable part of the world in respect to food as well as in other ways, for four main reasons: (1) there is a great variety of good food; (2) it is constantly available; (3) it is well cooked; and (4) it is served regularly.

(1) Not only does the cyclonic zone raise as great a variety as the subtropical zone except perhaps in the matter of fruits, but it brings still other varieties from other climates. On the farms people usually raise several kinds of grain and vegetables as well as apples or other fruits, chickens, eggs, and cows. In the towns because of the activity of trade, food of every kind comes from all parts of the world. Even in winter the markets provide fresh fruits from tropical countries and green vegetables with their health-preserving vitamines from regions like Florida and Tripoli. Only among the most ignorant and poverty-stricken people is there danger from great monotony of diet. All wise people, even though their means are limited, eat a sufficient variety to maintain health and vigor. Thus all the necessary food elements are supplied in due proportion.

(2) The people of cyclonic regions are rarely troubled by scarcity to-day and an excess of perishable food to-morrow. They need not half starve and then gormandize, as frequently happens to the people of all the less favored regions except the subtropical zone.

(3) In the cyclonic regions far more than elsewhere food is, on the whole, well cooked. This makes it much more appetizing than the raw or half-cooked food eaten by people like the Eskimos and the dwellers in the tropical jungle. Moreover, thorough cooking guards against disease by killing a great many germs.

(4) The people of cyclonic regions have the further advantage of having their meals at regular hours, three times a day. This not only economizes time, but is much better for health than are the irregular meals of tropical people who eat when they happen to obtain food.

With all these advantages the strong well-fed people of the cyclonic zone owe it to the rest of the world to teach the more backward races how to insure themselves a constant supply of varied food properly prepared.

## QUESTIONS, EXERCISES AND PROBLEMS

1. With the aid of the table near the beginning of this chapter examine a breakfast which consists of fruit, cereal, eggs, bread, butter, coffee, milk and sugar. How far is this a well balanced meal? On an outline map of the world shade the areas where you think that an ordinary person of moderate means could obtain such a breakfast regularly. Explain what types of regions you exclude.

2. It is claimed that enough food is raised in France to supply a well balanced diet during the whole year to each member of its population. In the article on France in the Statesman's Yearbook study the sections entitled "Agriculture" and "Exports." In the light of these sections and of the table at the beginning of this chapter, write a criticism of the probable truth of this statement.

3. In England more and more space is being given up to market gardens. Give reasons for this and explain its wisdom in comparison with the wisdom of raising wheat or cattle, or of letting the farming population work in factories.

4. Suppose the area within 50 miles of your home to be cut off from outside sources of food. List the changes this would make in the following respects: (*a*) variety of food. Consider the main items of your diet derived from near at hand and those brought from a distance, noting the place whence they come. (*b*) The healthfulness of your diet. Would cereals, meats, dairy products, fruits, sugar, vegetables or beverages be chiefly cut off? Would the community suffer most from lack of carbohydrates, fats, proteids, acids, or vitamines?

5. The early colonists of America relied at first on corn and game for their chief food. Discuss the advantages or disadvantages of such a diet. Discuss also the value of the arrival from England of a ship carrying flour, bacon, cheese, so far as improvement in diet was concerned.

6. During the latter part of the Great War, it was exceedingly important to get wheat for western Europe to make up for the deficiency caused by the cutting off of supplies from south Russia. Classify the countries from which wheat could be imported to meet this need with regard to (*a*) amount exported annually in a normal year; (*b*) distance from western Europe; (*c*) the season at which the harvest falls.

7. Classify the chief trees which furnish food for man according to the zone of vegetation in which they thrive.

## CHAPTER XX

## MAN'S CHANGING SURROUNDINGS.

**Geographic Constants and Variables.**—Among the physical features of man's surroundings three, namely, location, land forms, and water bodies may be regarded as constants. The location of a place in relation to the poles and the equator or in relation to the lands and the oceans never changes, or at least changes so slowly that man is not conscious of it. Land forms are almost equally constant. Although the mountains may be worn down a little by erosion in the course of hundreds of thousands of years or raised a little higher by earth movements, they have not changed appreciably during the period covered by human history. With water bodies, the third element, the changes are equally unimportant except where variations of climate cause a desert lake, for instance, to dwindle in size, or a river like the Hwang Ho to become China's sorrow, or where man himself has built reservoirs, enlarged harbors, and reclaimed land from swamps or from the sea as in Holland.

Soils and minerals, the fourth great feature of man's physical surroundings, are more variable than the first three. Their changes, however, are either extremely slow or are due to man's own actions. Slow changes consist of the weathering of new soil, the accumulation of humus, and the formation of new mineral deposits by water that percolates through the rocks. These changes, however, are almost as slow as the changes in relief. The changes caused by man are more important. By cultivating the soil he robs it of its wealth. In China thousands of square miles have entirely lost the valuable soil cover because it has been washed away after the cutting down of the forests. In long-cultivated countries like Greece the soil has suffered much from constant cultivation without the addition of proper fertilizers. In Italy and other countries such exhaustion of the soil probably helped to cause the fall of the Roman Empire. Mineral deposits are likewise exhausted by man. In any mining country one can find towns like Virginia City, Nevada, that once were prosperous, but now have fallen to ruins because the earth has been robbed of its mineral deposits.

Climate, the fifth great feature of physical environment, is far more variable than any of the others. A cool wet summer may cause an Adirondack resort to be almost deserted, and thus bankrupt the hotel keepers, cause the guides to go elsewhere for a living, and make the boats and railroads run at a loss. A drought of a few months may cause famines like those we have discussed in India.

Often the climate grows wetter and colder for a few years and then becomes drier and warmer until it returns to the original condition, only again to enter upon a new cycle of the same sort. There are irregular climatic cycles of every grade from those of about three years, through those of 11, 33, 100, and so on up to the great cycles known as glacial periods. Thus, climate is the one great physical condition which varies appreciably. The other four—location, land forms, water bodies, and soil and minerals—are relatively constant except when long periods are considered.

Though most of the physical features of man's environment change but little, the plants and animals upon which man depends so largely are subject to many variations. These usually take the form of migrations, blights, and diseases. Let us begin with some of the variations in plants and animals and then pass to those due directly to climate.

**Examples of Geographic Variables. Animal Migrations: Locusts.**—The migrations of animals illustrate the effect of geographic variables. Those of insects are, on the whole, much more important than those of larger animals. One of the best known migratory insects is the locust. Its movements depend largely upon climate. In years when the eggs are able to hatch in large numbers vast swarms of the insects infest states like Kansas. Having eaten every green thing where they were hatched they begin to migrate, and move across the country by the million, all headed in the same direction, although no one knows why. They leave behind them a desert peopled by poverty stricken and discouraged farmers.

**The Destructive Effect of the Cotton Weevil.**—The damage done by locusts is probably small compared with that due to various insects which attack cotton. It is estimated that insects damage the cotton crop of the United States to the extent of $100,000,000 annually. A little more than half of this is due to insects which live permanently in the cotton area. The remainder is due to a small gray beetle called the boll weevil. Since about 1860 the weevil has been slowly spreading from its original home in Mexico into the cotton producing region of the United States. (See Fig. 100.) The weevils sting the flower buds in order to lay their eggs, which are deposited at the base of the young bolls or pods. This ruins the cotton. As the weevil occupies new territory year by year new groups of farmers are added to those who suffer. To get rid of the weevil the American farmers have tried many methods such as killing the weeds on which the insect lives part of the year, and introducing new and resistant varieties of cotton, such as that of Guatemala.

**How the Phylloxera Ruins the Grapes.**—The phylloxera, a kind of plant louse which ruins grape vines, has done even more damage than the boll weevil. Its original home is the United States, but there the vines have become immune to its attacks. That is, in the course of many years, those that were most injured have been killed, and only those that could endure its ravages have lived.

About 1860 the phylloxera was accidentally introduced into Europe through the importation of American vines. It spread at once and did enormous damage. For instance, in 1865-7 the little commune of Graveson near Bordeaux in France obtained its ready money for taxes, clothing, and incidental expenses by producing 220,000 gallons of wine each year. In 1868 the phylloxera reached this section, and by 1873 the production of wine had fallen to 1100 gallons. By 1888 the total loss to France as a whole is estimated at two billion dollars. In some places the consequent poverty of the farmers led to violent political agitation, for people often have the strange idea that troubles due to geographical conditions can be remedied by changes in the laws.

When once the phylloxera is introduced the only remedy is to root up all the vines and start with new ones raised from American stock. Not only France, but almost every grape-raising region in the world has suffered more or less in the same way.

**Scales and Moths.**—Many other insects, and also certain fungi, do similar damage. The orange scale, for instance, has almost ruined many orange groves. In the northeastern United States the gypsy, brown-tail, and other moths which were introduced from Europe during the latter part of the nineteenth century have greatly injured certain species of trees. Massachusetts, for example, has spent millions of dollars in a single year to get rid of these pests or at least to prevent them from migrating into new territory. The only real remedy seems to be the introduction of parasitic contagious diseases which spread from moth to moth. When the weather is warm and moist such diseases kill the insects by the million.

**Plant Migrations.**—The migrations of plants are as harmful as those of animals. The daisy, for instance, was introduced into America from Europe, and then spread over millions of acres. It diminishes the hay crop by hundreds of thousands of tons, for it crowds out good grass, exhausts the soil, and is itself not eaten by any domestic animals. The Scotch thistle does similar harm.

Even greater damage is done by small forms of yeast-like plants called parasitic fungi, which grow on other plants as mold grows on cheese. Among the worst of these are the wheat rust and the potato blight, which sometimes ruin the crop in unusually wet seasons. In the eastern United States the slowly spreading chestnut blight has ruined many a great tree like that under which stood the village blacksmith's shop in Longfellow's famous poem. The only known remedy is to cut down all the chestnut trees in a broad belt, as has been done in Pennsylvania, so that the blight may have nothing upon which to live.

**Migrations of Disease.**—Men and animals as well as plants are often attacked by pests which spread from place to place and hence are variables. For instance, influenza is one of the most dangerous diseases because it is highly contagious and even if its victims survive they are weak for a long time. In this case, as in most variables, two factors are concerned: (1) the bacteria which cause the disease, and (2) man. The bacteria are present in most countries at all times. Occasionally, for reasons not yet understood, they suddenly become extremely virulent and devastating epidemics occur. Man's variations are better understood. Under ideal conditions of climate, ventilation, and food, he is able to resist the disease even in its worst form, provided his health is not impaired in other ways. Rarely, however, do these ideal conditions prevail, and hence epidemics break out and cannot be stopped. Every winter there is a mild outbreak because man's power of resistance is at a low ebb. One of the last great epidemics developed in Asiatic Russia in 1889, perhaps because of a severe winter and poor food. It then spread rapidly without apparent regard to weather or climate, following the lines of human intercourse along the world's great trade routes to the remotest countries. In 1918 a far worse epidemic broke out, apparently in connection with the Great War. More people died than in any epidemic since the notorious Black Death of the fourteenth century. In the United States half a million people died either of influenza or of the pneumonia which often follows it. In the world as a whole about 15,000,000 people, or nearly one in every hundred, fell victims to the disease; in India the number was 6,000,000, or one in 50; in Mexico one in 25; in Yekaterinburg, a Russian city as large as Savannah, a third of the population perished, and in some Indian cities, half. The great ravages of influenza in tropical countries and also in regions like Russia, where the people were especially weakened by war and famine, show that the greatest safeguard against the disease is a general condition of good health. The great mortality from influenza in the camps of our own army shows how the crowding of people into small areas favors the spread of infectious diseases.

**Microscopic Creatures as part of Man's Environment.**—Since the microscope was invented people have learned the importance of tiny germs including both the minute animals called "protozoa," such as produce malaria, and the equally small plants called bacteria, such as spread typhoid fever. These tiny creatures are a part of man's geographic surroundings as much as the bigger forms of life such as horses, tigers, fish, and insects, or trees, bushes, grass, and corn. Because the protozoa and bacteria, however, can be seen only under a powerful microscope and are known only by the results they produce they were long ignored. Their effects upon man, however, are fully as important as those of the larger forms of life, as is clear from the examples of diseases which we have just considered. Man must study the minuter forms of life with special care because of their great variety, and because they are so variable in their activity. He can plan to meet the attacks of tigers and wolves, but it is harder to meet the attacks of tiny creatures so small and numerous that we may take them in by the million at every breath and so deadly sometimes that they kill a thousand men where wild animals kill only one.

**The Newfoundland Fisheries.**—Thus far in considering geographical variables we have concerned ourselves largely with pests. Let us now look at the movements of useful animals such as the fish of the Newfoundland Banks. More than half of the people of Newfoundland are engaged in catching and curing fish. The total catch varies greatly from year to year because of changes in the fishes' food supply, in the amount of salt in the water, and in conditions of temperature, storminess, and winds. Hence the island sometimes enjoys prosperity and sometimes suffers distress. From about 1860 to 1868 the Newfoundland fisheries were so unproductive that widespread destitution prevailed among the working classes. Hence people began to turn to agriculture and stockraising and farming received such a start that it has increased ever since, in spite of the cool climate. This is fortunate, for Newfoundland cannot prosper unless other resources beside fishing are exploited. A less favorable result was the introduction of a system of poor relief, not only for people who were unable to work, but for the able-bodied. This proved very demoralizing, for people said that if the government would support them, they were not going to work. Even though the fisheries became successful again in 1869 the poor relief system had lasted long enough to do serious harm.

**Weather as a Geographic Variable. The Galveston Hurricane.**—Many geographic variables such as insect pests, epidemics, and the migrations of fish are due indirectly to the weather. The direct effects of variations in the weather are equally important. For instance, in September, 1900, Galveston, Texas, was visited by a hurricane from the West Indies. A violent wind blew for eighteen hours, reaching a maximum velocity of 84 miles an hour. The waters of the Gulf of Mexico were piled up in enormous waves that swept across a large part of the city, destroying or badly damaging more than 8000 buildings, and entailing the loss of about 6000 lives and of property valued at $30,000,000. Thereupon the city set to work to prepare for the recurrence of this variable geographic condition. A wall of solid masonry was built for 5 miles along the water front at an expense of $2,000,000. The entire grade of the city was raised from 1 to 15 feet above its former level.

In August, 1915, there came another hurricane nearly as violent as that of 1900. The maximum velocity of the wind was 93 miles per hour, but the tide at the highest rose only 12 feet instead of 20 as in 1900. Thanks to the seawall and to the warnings sent by the

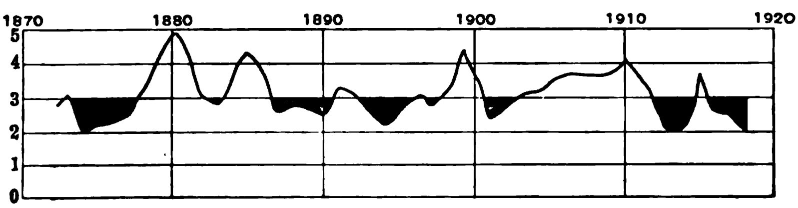



FIG. 115.—Summer Rainfall in Kansas.

Rainfall of May, June, and July, weighted, and smoothed to show the effect on the corn crop. Black shading indicates drought.

Weather Bureau to people living beyond the protection of the wall the loss of life in 1915 was only about 275, while the property loss was much less than before.

**Rainfall and Settlement in Kansas.**—Rainfall is another element of weather, the variations of which are of great importance. In western Kansas, for example, the corn crop depends on the summer rain, especially that of July, when the ears are developing most rapidly. The curved line of Fig. 115 shows how the variations of the rainfall of May, June, and July have affected the farmers of western Kansas since 1870. When the curved line is above the straight line representing the average rainfall the farmers prosper. When it falls below, they often cannot raise enough to support their families and pay their debts.

The meager rainfall from 1870 to 1877 did little harm, for then there were few settlers in western Kansas, and most of them depended upon cattle more than on crops. Even among these, however, some became so poor that they had to move away. The period from 1878 to 1886 was excellent, for the rainfall was abundant, Settlers moved into western Kansas in considerable numbers. Each farmer received from the government a "quarter section," that is, a quarter of a square mile of land, or 160 acres. For a few years everyone was enthusiastic, and the land available for settlement was rapidly taken up.

Then came a period of scanty rainfall lasting till about 1896. Thus the climate and the crops completed a cycle. Dry conditions returned just as the summer returns in the shorter cycle of the year. Year after year the rainfall was scanty and the crops were poor. The farmers were able to struggle along only by mortgaging their houses and getting more and more into debt. At last, with no improvement in rainfall, conditions became so bad that farms were abandoned by the hundred. Many families were too poor to pay railroad fares. They packed up all their belongings in great farm wagons, and drove away seeking new homes. During this low period in the cycle of rainfall not only did the farmers themselves suffer, but the merchants who supplied their wants, the people back in the East who had loaned them money, the manufacturers who made the goods that they consumed, and the railroads that usually carried the crops that they raised.

**How Dry Farming Helps in Regions of Scanty Rainfall.**—Little by little the farmers of dry regions are learning to provide against drought. In Kansas, for example, during the comparatively favorable period since the nineties they have learned to preserve the water in the soil for many months or even from one year to another. They do this by plowing or harrowing after every rain in order to break up the crust that forms when the soil dries. Thus the surface is always covered with a layer of soft, dry dust. Anyone who has made bread knows how flour, which is merely wheat dust, almost refuses to allow the water to enter it except by the aid of vigorous stirring. Such a layer of dust on the surface of the fields prevents the ground water from evaporating and hence is a great help to the crops. This method of "dry farming" enables crops to be grown with comparatively little rainfall. It is a great help to the farmer, but demands a large amount of labor. Even where dry-farming is practiced, however, it is only a partial remedy for scanty rainfall. Abundant rainfall still causes prosperity, while scanty rainfall may bring poverty.

**Variations in Rainfall and Migration from Western Europe.**—One of the most important occurrences of the past hundred years has been the migration of Europeans from the Old World to the New. The fundamental cause is of course the fact that America is a new land with abundant opportunities, while Europe is an old land densely populated. These conditions are a *constant* cause of migration, and if acting alone would give a rise to a steady flow of people into the United States. Other *variable* factors, however, enter into the problem from year to year. From 1914 to 1920 the Great War was the chief factor in controlling migration, but under ordinary conditions changes in rainfall or climatic cycles are the chief cause of variation. Too much rainfall in Scandinavia, Britain, the Netherlands, and Germany may be as bad as too little in Kansas. Those countries are so far north and are usually so well supplied with rain that when the rainfall is above the average, vegetation does not get enough sun and warmth. Hence the crops are scanty; poverty and discontent arise; people want to get away to another country; and there is much emigration. The United States lies enough farther south than northwestern Europe so that on the whole it is benefited by abundant rainfall. Hence prosperity is apt to prevail here when poverty prevails there, provided the rainfall cycles are the same in the two places, which is often the case. Thus good conditions here may attract people from Europe just when poor conditions there are driving them away.

**How too Much Rain Brings the Irish to America.**—The European region that has been most affected by emigration to America is Ireland. Through emigration the population of that country has been reduced by half. At the census of 1841 there were 8,200,000 people, and in 1911 only 4,400,000. As in many other cases the emigration from Ireland is due to a constant cause which is within human control, and a variable geographical cause which is beyond human control. The constant cause is the unfavorable social conditions. For instance, the land has till recently been largely owned by a few absentee landlords who did not often visit their estates and who cared little for the poor tenants provided the rent was paid. The variable cause is the fluctuations in the rainfall, and hence in the potato crop, the chief agricultural resource of Ireland.

Previous to about 1845 Ireland enjoyed a comparatively dry period with excellent crops most of the time. The population increased until in 1845 it reached a maximum of 8,300,000. Then came a series of damp years with such complete failure of the potato crop, that 200,000 to 300,000 people died of starvation and fever. The British government provided work for over 700,000 people at one time, but this was not enough. Then food was distributed in enormous quantities, and over 3,000,000 people were at one period supplied with rations. Nevertheless such great discontent arose that in 1848 a rebellion was attempted.

Perhaps the most important result of the excess of rain was a rapid emigration to America beginning in 1846. In five years the population diminished to 6,600,000, a loss of 20 per cent. During the succeeding dry favorable period the rate of emigration declined rapidly, as is shown in the accompanying table. In the eighties, however, another prolonged wet period with poor harvests made the bad social conditions still worse, and the people again flocked to America. If the climate of Ireland had been less variable, the important Irish element in the United States would still be here because of the constant cause of emigration found in social and economic conditions, but it would presumably be much smaller than is actually the case.

POPULATION IN IRELAND

| Date. | Population. | Decrease in Population. | Percentage of Decrease. |
|---|---|---|---|
| 1841 | 8,200,000 | ........ | |
| 1851 | 6,600,000 | 1,630,000 | 20 |
| 1861 | 5,800,000 | 770,000 | 12 |
| 1871 | 5,400,000 | 390,000 | 7 |
| 1881 | 5,100,000 | 240,000 | 4 |
| 1891 | 4,700,000 | 470,000 | 9 |
| 1901 | 4,500,000 | 240,000 | 5 |
| 1911 | 4,400,000 | 80,000 | 3 |

**How Rainfall Cycles Affect the American Farmer.**—Too much rain and too little are both harmful, but in the United States more harm comes from too little than from too much. Corn illustrates this. The corn produced in the United States is worth over three billion dollars each year, or about as much as all the ores, metals, and other mineral products including coal, iron, petroleum, copper, gold, cement. and many other less valuable products. Its variations from year to year, however, are very great. For instance, in 1894 about one billion two hundred million bushels were raised, while in 1895 the crop was a billion bushels larger. Since corn was then worth 50 cents a bushel on the farm, the difference between the amount of money received by the farmers in those two years would be nearly $500,000,000, which was as much as a billion now. There was a similar difference between 1901 and 1902, while differences of 300,000,000 bushels from one year to the next are common.

The chief cause of such variations is rainfall. Corn can get along with a small supply of moisture during the early and late parts of its life, but from the end of June to early August when the ears are swelling, plenty of water is essential. The great corn producing States of Ohio, Indiana, Illinois, Iowa, Missouri, Nebraska, Kansas, and Oklahoma with the corn growing parts of the neighboring States plant 80 to 90 million acres of corn each year. If the July rainfall of this area averages about 2½ inches in one year and 3½ in another the difference in the yield of corn is about 6½ bushels per acre, or the huge amount of more than half a billion bushels. If the price on the farm is a dollar per bushel, the value of this one inch of rain is more then $500,000,000. Another inch of rain adds nearly half as much more to the value of the crop. It scarcely seems credible that a single inch of rain can produce such tremendous results, even though it covers such a large area. Surely rainfall is a geographic variable of almost unlimited power.

Luckily the whole country never suffers from deficient rainfall at one time. Yet there are years such as the early nineties when the deficiency of rain is very widespread. It was such a deficiency that caused the corn crops of 1894 and 1901 respectively to be worth half a billion dollars less than those of 1895 and 1902. Thus the income of the average corn-raising farmer was reduced two or three hundred dollars.

Think what it means when not only the corn, but many other crops respond to abundant rainfall. Not only do the farmers prosper, but the railroads receive far larger sums than usual for the freight on the abundant crops and on the goods that are bought in exchange for them. The merchants prosper, for many more shoes, hats, suits, dresses, plows, clocks, knives, automobiles, and all sorts of manufactured goods are bought by the farmer in the good years than in the bad. Many factories also prosper, for since the farmers buy more goods than usual, the factories run on full time. Thus few people are out of work, and the manufacturing population as well as the farmers have more than the ordinary amount of money to spend. Newspapers and magazines are bought more frequently than at other times, moving pictures and other amusements are patronized with greater freedom. Moreover, many farmers who have been in debt are able to pay off their mortgages so that capital is available for new enterprises. Altogether the whole country feels a wave of prosperity which shows itself not only in business, but in quiet political conditions, in great gifts for universities, hospitals, and other public institutions, and in a general feeling of satisfaction and encouragement.

**Ancient Climatic Cycles.**—*(1) Ruins as an Evidence of Decrease in Rainfall.*—In past centuries climatic cycles seem to have gone to greater extremes than those of our own day and to have been one of the important factors in the rise and fall of nations. The chief evidence of this is found in (1) ruins, (2) the level of salt lakes, (3) the growth of old trees. Palmyra in the Syrian Desert is one of the best examples of a ruin showing evidence of changes in climate. In the early centuries of the Christian era Palmyra was a great city as large as modern Damascus, which has a population of 150,000. Ancient writers speak with enthusiasm of its sweet water and beautiful gardens. Its caravans traveled all over western Asia, and it grew so wealthy that its rich citizens took pride in adorning it with wonderful colonnades and temples. To-day Palmyra is a vast desolate ruin in the midst of the desert, and harbors only a village of about 1500 people. Its water is still derived from the old aqueducts, but instead of being sweet and abundant, it has a disagreeable odor of sulphur, and is so scanty that the people cannot get enough to irrigate even the small gardens on which they now depend. Such conditions not only here, but in hundreds of other places, seem to afford conclusive evidence that during the past 2000 years the progress of great climatic cycles has caused the rainfall and the population to dwindle. It may be that during the rainy portion of another cycle Palmyra will again become a great city.

(2) *How Salt Lakes Show Changes of Rainfall.*—Salt lakes are a particularly sensitive index of changes of climate since, having no outlets, they rise and fall in response to increased or decreased rainfall. For example, Owens Lake at the eastern base of the Sierras in California must formerly have been fresh, for an old outlet channel, remnants of a great beach, and cliffs cut by the waves prove that it once stood 180 feet higher than now and sent out an abundant overflow. When the Los Angeles aqueduct was being built the amount of salt now in the lake was found to be only as much as would be brought in by the Owens and other tributaries in not much more than 2000 years. Therefore geologists conclude that at the time of Christ or a few centuries earlier the lake must have been a body of fresh water with an outlet. If that is so, the climatic cycle which enabled Palmyra to prosper so greatly must have had a similar effect in southern California. Other lakes in our own country and especially in Asia show similar indications of changes of climate so that their evidence is as widespread as that of ruins.

**How the Caspian Sea Shows Alternate Wet and Dry Epochs.**—The changes of climate during historic times do not seem to belong to one cycle but to several. Since records of the level of the Caspian Sea are available for 2000 years that salt lake furnishes an uncommonly good measure of the climatic cycles of the Christian Era. These records relate to three main kinds of facts: (1) the distance from the lake shore to known land-marks; (2) old walls like the Great Chinese Wall and old buildings which were built on dry land but are now submerged beneath the lake; (3) old buildings which the lake once reached, but which are now above its level. All these kinds of facts indicate that at the time of Christ or earlier the Caspian Sea stood at a level 75 or 100 feet above the level of to-day. Six or seven hundred years later the climate was so dry that the lake stood even lower than now, as is indicated by the ends of two great walls constructed to keep out barbarians. A few hundred years later, however, in the tenth century, the wet part of a cycle was reached, for a Persian geographer tells us that the Caspian Sea had then risen some 40 or 50 feet to the level of a certain tower, and a little later the water probably rose still higher. It is interesting to know that at this same time Palmyra partially recovered.

This does not end the fluctuations of the Caspian Sea, however, for in the twelfth or thirteenth century a second dry period again lowered the lake level. A century later the old records tell us that the Caspian again rose to a height of nearly 40 feet above the present level. Thus it appears that the Caspian Sea stood at a surprisingly high level at the time of Christ, at a low level six or seven hundred

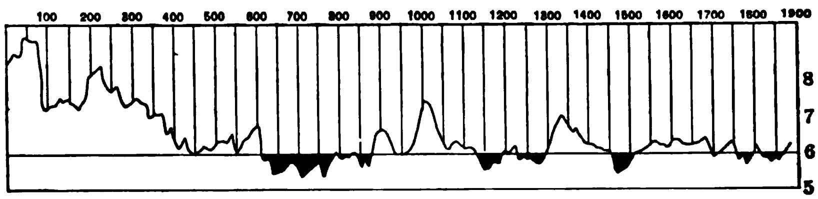



FIG. 116.—Changes of Climate in California During the Christian Era.
Black shading indicates drought.

years later, high again about 1000 A.D., low in the thirteenth century, high in the fourteenth, and now low once more. Hence it is clear that there have been two complete main cycles of rainfall since the time of Christ, and we are now in a third.

(3) *How Trees Show Climatic Cycles.*—Within 50 miles of Owens Lake, but on the other side of the Sierras, the famous Big Trees of California furnish a still fuller record of these same climatic cycles and of many smaller ones during a period of over 3000 years. The rings of trees vary in thickness for several causes, but in a dry climate like that of southern California the chief cause is the amount of rain and the season at which it falls. As hundreds of the Big Trees have been cut down for fence posts and matchwood, it is possible to measure the thickness of the rings as they appear on the stumps. By counting in from the edge it is easy to find a ring that was formed in 1776, for instance, in 1492, or at the birth of Christ.

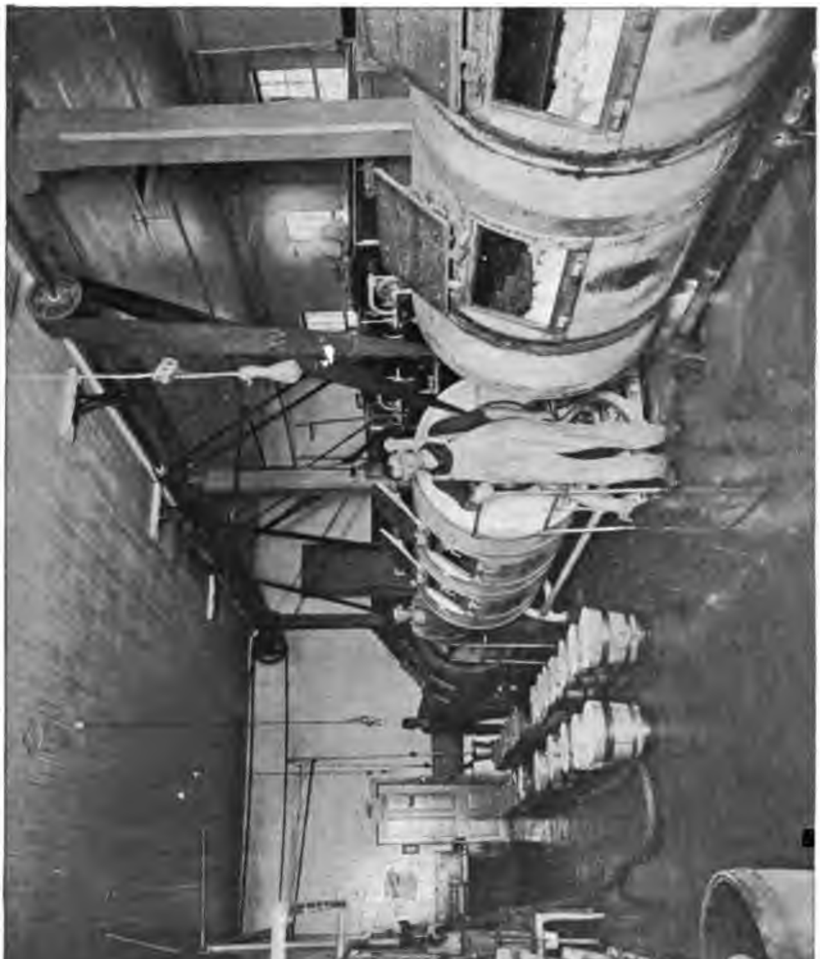
The rings dating from the time of Christ are thick and indicate that at that time, when Palmyra had an abundant supply of water, when Owens Lake overflowed and there was high water in the Caspian

Sea, the Big Trees also had plenty of water and grew rapidly. Six or seven hundred years later when Palmyra was abandoned and when the Caspian Sea stood 15 or more feet lower than at present, the trees formed only narrow rings, because the climate was dry. The way in which the growth of the trees has varied is shown in Fig. 116. The high parts of the curve indicate abundant rainfall. The black shading at the bottom indicates periods of comparative aridity in the subtropical belt.

**Variations in Climatic Cycles According to Latitude.**—Climatic cycles, whether large or small, produce uniform effects in similiar climatic regions, but quite different effects in different zones. The wonderful Maya ruins of Guatemala, for example, appear to indicate that when California had abundant rainfall, the northern parts of Central America suffered a decrease. Thus at the time of Christ and for a few centuries thereafter, and again about A.D. 1000 Guatemala and Yucatan appear to have been drier than now. Many of the most remarkable ruins are located in places where the forest is of the equatorial type and so dense and malarial that agriculture and civilization are now apparently impossible. In the days of the Mayas, however, the climate was apparently dry enough so that conditions were like those of the more favorable jungle regions instead of like those of the dense rain forests. All these changes, both in the subtropical and equatorial regions, were apparently due to a shifting of the location of the climatic belts.

It is important to understand that the changes of climate during the cycles of historic times do not appear to have caused great changes in temperature. Variations of temperature from day to day, however, were apparently more numerous than now because of more frequent cyclonic storms which at certain times followed paths nearer the equator than at present.

**Effect of Climatic Cycles upon Man.**—(1) *How Economic Prosperity Varies.*—Climatic changes appear to have produced three kinds of effects, economic, political, and physical. In the early days of Rome, about 400 B.C., five acres of cultivated land together with space for pasturage was considered enough to support a family. About 200 B.C., however, when the trees of California were growing particularly slowly and the lakes of Asia were dwindling, a great change became evident. The careful agriculture of the past with its abundant crops and careful fertilization disappeared. The farmers became so poor that many of them gave up their land, which was sold at low prices and fell into the hands of large owners. The new owners stocked it with cattle and sheep since ordinary farming did not pay. The people who remained on the farms fell so deeply into debt that



*By courtesy of the U. S. Dept. of Agriculture.*

FIG. 117.—An American Butter Factory.

One of the modern methods that help to make cattle yield a large return in cyclonic regions.

they were almost slaves. Many were so eager to escape from this condition that they flocked to the cities in search of work, until laws were passed which forbade them to leave their homes. This, it will

FIG. 118.—A Ruined Tower in Eastern Persia.

The town surrounding this old Mohammedan mosque in Seistan has been abandoned because of the fall in the level of the neighboring lake and the consequent lowering of the water table.

be seen, is like what happens in our own day during dry periods in western Kansas, only far worse. It happened not only in Italy, but in all the countries around the Mediterranean Sea as far east as Persia and central Asia. Other causes such as exhaustion of the soil and misgovernment helped to produce these bad conditions, but they would not have done so much harm, had they not happened during the dry part of a climatic cycle.

At the time of Christ the return of favorable climatic conditions did much to help Rome recover her prosperity, but two centuries later there began a decline in rainfall which was one of the main causes of Rome's final collapse.

(2) *How Political Life Varies.*—The drought and poverty of the dry parts of climatic cycles are apt to exaggerate political troubles. For example, in the second century B.C. the taxes which the Roman farmers had previously paid with ease from full grain bins became very hard to pay now that the bins were half empty. Hence Rome suffered from what is called the Slaves' Revolt, and from other agrarian troubles. The famous Gracchi brothers lost their lives in a vain attempt to remedy the trouble, but when the rainfall increased the remedy was easy.

Another political effect of the dry part of climatic cycles is barbarian invasions. Nomads such as those of central Asia are the first to feel the effect of increased aridity. The springs in the desert dry up, grass for pasturage is unusually scanty, and the nomads are forced to seek new pastures. Many of the barbarian invasions of Europe during the early part of the Christian era appear to have been due to this cause. Finally in the seventh century the greatest of all outpourings from the desert occurred just at the time when the trees, the lakes, and the ruins indicate that the climate of subtropical and desert regions was driest. Under the influence of the Mohammedan religion the Arabs surged out and overwhelmed all the surrounding regions. Their new religion kept them together and guided them, but the dryness of the desert apparently made them ready for a migration.

Thus large parts of the Roman Empire changed their political allegiance.

(3) *How Human Energy Varies.*—We have already seen that variations in the weather from day to day are one of the greatest stimulants to human activity. Apparently the part of climatic cycles which has abundant rain in subtropical climates has many more storms and much more variable weather than the dry part of the cycle. Therefore the wet part is stimulating and people have much energy. This seems to be one of the great reasons why the people of countries like Greece, Palestine, Egypt, Mesopotamia, and Persia were much more energetic in the past than at present. In those days they apparently had somewhat the same kind of climatic stimulus which the people of the United States and northwestern Europe now have.

## QUESTIONS, EXERCISES AND PROBLEMS

1. Palestine, when first occupied by the Children of Israel, is described as a land flowing with milk and honey. A little further north in Syria, according to a careful American archæologist, at about the time of Christ, "an area embracing somewhat more than 20,000 square miles was more thickly populated than any area of similar dimensions in England or in the United States is to-day, if one excludes the immediate vicinity of the large modern city . . . Mile after mile of this barren gray country may be traversed without encountering a single human being. Day after day may be spent in traveling from one ruined town to another without seeing any green thing save a terebinth tree or two standing among ruins . . . . No soil is visible anywhere except in a few pockets in the rock from which it could not be washed by the torrential rains of the wet season. Yet every ruin is surrounded with the remains of presses for the making of oil and wine. Only one oasis has been discovered in these high plateaus."

Explain the preceding facts. Show how and why man's surroundings in Palestine and Syria have changed in each of the following respects: (*a*) vegetation; (*b*) soil; (*c*) agriculture; (*d*) density of population.

2. Study the diagrams of rainfall in subtropical, monsoon and mid-continental regions, Figs. 83, 84, and 94. Show in each case what effect a diminution of rainfall and a shortening of the rainy season would have upon the following conditions; (*a*) the seasons of planting and reaping; (*b*) the character of the crops; (*c*) the use of animals; (*d*) the depth of soil on the mountains. Which of the three kinds of regions would be most influenced? Why?

3. In any volume of the *Mortality Statistics* issued by the United States Census Bureau, look up the table headed "Deaths by Months of Occurrence." Plot the monthly number of deaths for the following places, beginning and ending each curve with January: (*a*) California; (*b*) Minnesota; (*c*) Maine; (*d*) Missouri; (*e*) North Carolina; (*f*) registration cities of Alabama; (*g*) your own state or city. (These diagrams will be much more accurate and instructive if the numbers given in the table are first divided by the number of days in the month, and the results are again divided by the number of inhabitants reckoned in hundreds of thousands. This will give the number of deaths per day for each hundred thousand people, and the resulting curves can be compared without the necessity of making allowances for the number of days in the month and the number of inhabitants.) Interpret each curve as follows: (1) Which seasons are best and worst respectively and how much do they differ in percentages? (2) What effect is produced by the onset of warm weather? By the continuance of such weather? (3) The same for cold weather. (4) Sum up the effect of the changes of the seasons in each case, and show where the effect is greatest. Be sure to make full allowance for the number of inhabitants, for otherwise a small state or city will invariably appear more healthful than a large one.

4. Discuss Fig. 100, as an illustration of a geographic variable.

5. Describe in detail some variable geographic factor with which you are familiar, and discuss its effect.

# PART VIII

## *MAN'S RELATION TO MAN*

## CHAPTER XXI

### POLITICAL GEOGRAPHY

In all parts of the world geographical surroundings have a strong influence on political conditions. This is equally true among primitive people and among those most highly advanced. For example, in eastern Persia the chief political idea of the primitive "Fowlers" who live on birds and cattle in the vast swamps of Seistan is to evade paying taxes. This is because they are easily able to hide themselves and their simple belongings among the tall reeds where the tax collector cannot find them. The settled agricultural people on the open irrigated lands not far away, on the contrary, look upon taxes as no less inevitable than the seasons, for their environment furnishes no way of escape. Among advanced people environment produces a similar political effect when it causes the coastal sections of a country to vote for ship subsidies, while the interior is strongly against them. Each of the great elements of geographical environment plays its part in causing political differences, for location, land forms, water bodies, soil and minerals, climate, and plants and animals all make some people want the government to act in one way and some in another.

(1) *Why the East and the West Differ as to Immigration.*—The opposed desires of the East and West of the United States as to immigration well illustrate the political effect of *location*. The western United States, which faces Asia, does not want Asiatic immigrants. Its people feel so keenly on this question that some of them have engaged in riots against the Chinese and Japanese, and have compelled the country as a whole to adopt the policy of excluding these races. The East, because it faces Europe, is indifferent about Asiatics, but is intensely interested in European immigration. For many years the East wanted as many immigrants as possible, and hence was against all restrictions. Now, however, the East is in much more

danger from undesirable immigrants than is the West. Hence in almost every session of Congress Eastern members introduce bills to restrict European immigration. They feel that unless the level of the immigrants from the backward countries of eastern Europe is raised, this country will soon find itself greatly injured because of the dull minds inherited by great numbers of its citizens.

**Why the Coast and Interior Differ as to Congressional Appropriations.**—Although the East and the West differ as to immigration because they face different oceans, they agree with one another and differ from the interior of the United States as to spending money for harbors, because they are both on the sea-coast. Both East and West want large appropriations for the navy, for coast defenses, for harbor development, and for the encouragement of foreign trade. The interior States, however, are inclined to say that the United States is so strong and rich that no power will ever dare attack us, and the country will prosper no matter whether the government helps foreign trade or not. What they want is large appropriations for river improvement, national highways, irrigation projects, forest reserves, and national parks. They say that if vast sums are spent to deepen harbors on the Atlantic or Pacific coasts, equally large sums ought to be spent for improvements in States which have no water-borne commerce.

This conflict of interests often leads to log-rolling and results in the so-called pork-barrel bill. Unscrupulous congressmen try to get appropriations for some project in their own district no matter whether it is good or bad, and all sorts of foolish compromises are the result. It is a grave mistake to think that money should be spent in one's own particular State whether it produces national benefit or not. People who do this overlook the fact that money spent on New York Harbor, for example, is a direct benefit to Chicago, St. Louis, and almost every part of the country, because it stimulates trade and reduces the price of imported goods. In the same way the coast States err when they oppose the spending of money for irrigation or for the building of great national highways. It is time for Americans to give up the prejudices and greed which spring from their location and ask only whether a given project will be a benefit to the nation as a whole, no matter where the money may be spent.

**How Belgium became a Victim to Location.**—Belgium illustrates the effect of location in quite a different way. Because she is located between Germany and France and on the best route from one to the other, Germany sent her armies across that little country in 1914. Thus Belgium, in a quarrel with which she had nothing whatever to do, suffered the loss not only of hundreds of thousands of men but of a multitude of women and children. Through starvation, oppression, and cruelty her people suffered as much as any of the chief parties to the quarrel except northern France. She also lost an enormous quantity of machinery and treasure; her factories were ruined, and her material progress set back for decades.

(2) *How Relief Influences Political Allegiance.*—While location causes political differences chiefly between people who live at some distance from one another, the *form of the land* may cause equally great differences between those in closely neighboring regions. In the Civil War the main line of cleavage was between the North and the South, but within the South the relief of the Appalachian Mountains caused a split between the highlands and the lowlands. The highlanders, by reason of their geographical surroundings, were poor and scattered, and their farms were small and unproductive. They could not raise large amounts of money-making crops like cotton and tobacco. Hence slave labor did not pay. Moreover, the mountaineers did not have the capital to purchase slaves. Hence throughout the whole Appalachian region from West Virginia southward the mountaineers did not agree with the slave-owning plainsmen, and would not consent to secede. Many of them joined the Northern army, and all welcomed the coming of Northern troops.

**How Relief Keeps the Balkan Problem Astir.**—On a map of the Balkans notice the numerous mountain ranges, and the many directions in which they run. Between them lie numerous plains, some of considerable size like those of eastern Roumelia in Bulgaria, and others mere little pockets among the mountains.

Into this region have come many sorts of people. Some, like the Turks, have found a resting-place here when want and famine or hostile invasions caused them to migrate from Asia to Europe. Others, such as the Jugo-slavs, have been forced out of the plains of eastern Europe by similar causes. Thus Montenegrins, Albanians, Serbians, Greeks, Bulgarians, Turks, Wallachs, and Roumanians are inextricably mixed. In a broad plain these people might gradually have become more or less unified as have the races from which sprung the English or the French. Each little valley or plain in the Balkan Peninsula, however, is more or less isolated by a mountain wall, so that the various races preserve their own social, political, and religious characteristics. Consequently they engage in almost continual quarrels. In addition to this, all alike have been discontented because of the poverty which generally prevails among mountains, and have been inclined to attribute their troubles to their neighbors or to the government.

For all these reasons the Balkans have always played a troublesome rôle in Europe. The Turks, when they were in power, abused and massacred the Christian races until they appealed to the powers of Europe for protection. When the Christians became supreme, they often ill-treated the Turks. Moreover, the Christians have abused one another most cruelly because of differences in creed, language, and race. First one Great Power, then another, and finally all together have tried to bring order out of the Balkan chaos, but always the mountains and the conditions which go with them have baffled such attempts. Austria took possession of the provinces of Bosnia and Dalmatia and gave them a stable but repressive government, but the mountaineers did not like foreign rule, and the Serbians of Serbia were continually inciting their fellow Serbians of the Austrian provinces against the government. Troubles of this kind in 1914 were the immediate cause of the Great War, although other and deeper factors were still more important. When Austria demanded a reckoning with Serbia the Russians stood by that little Balkan country and thus the great conflict was precipitated.

After the war the various Slavic races of the northern Balkans united in the republic of Jugo-Slavia, while Bulgaria, Roumania, and Greece remained much as before. At once, however, there arose great difficulties because Bulgaria and especially Jugo-Slavia each needed an outlet to the sea, while Greece and Italy wished to keep control of the whole Ægean and Adriatic coasts. Jugo-Slavia and Italy almost went to war over the port of Fiume, because this was almost the only place where the relief gave Jugo-Slavia an outlet to the sea.

(3) *Russia's Thwarted Efforts to Gain a Good Sea Frontage.*—Russia furnishes a good example of the effect of *bodies of water* upon political relations. That country has the longest coastline of any country in the world, but most of it is useless. Let us consider each of the four coasts: (*a*) The *Western* coast, bordering on the Baltic Sea, has a twofold disadvantage. First, the ports are closed by ice from three to five months or more in the winter. Second, all the commerce bound for the open ocean must pass through the narrow straits at the western end of the Baltic, which can easily be blocked by an enemy. During the Great War Germany was easily able to close the Baltic completely to Russian commerce. In spite of these disadvantages Petrograd, the chief seaport of Russia. lies on this coast.

(*b*) The whole vast northern coast of Europe and Asia is practically useless. During the Great War the closing of the Baltic by Germany compelled Russia to use the western part of her bleak *northern* coasts during the short open season. The ports of Murmansk and Archangel assumed a temporary importance, but this vanished with the return of peace.

(*c*) On the *east*, that is, on the Pacific coast of Siberia, Russia is hampered only a little less than on the north. Even as far south as Vladivostok the ports are troubled by ice for four or more months in the winter, and commerce is impeded. Therefore in 1895 Russia obtained from China the right to build a railroad through Manchuria, and to hold an ice-free outlet to the open sea at Port Arthur. She held this desirable harbor only a few years, however, for Japan had long coveted it and was desirous of asserting her influence in the northern parts of China. Accordingly, Japan declared war and expelled Russia from the coast of southern Manchuria.

(*d*) On the *south* Russia's only sea-coast was for a long time on the inland Caspian Sea and on the Black Sea, whose only outlet to the open ocean is through the narrow strait of the Bosphorus at Constantinople. Since the Turks held Constantinople and there seemed no prospect of obtaining a free outlet there, the Russians again and again considered the project of an advance across Persia or Afghanistan in order to reach the Persian Gulf or the Arabian Sea. In spite of some progress, however, they never succeeded, partly because of England's strenuous diplomatic opposition, but also because the deserts and mountains of Persia are serious obstacles to railroad building. Because of her inability to gain a desirable seacoast Russia has been greatly hampered. This cut her off from the rest of the Allies during the Great War, and the isolation thus caused was a great factor in her collapse and in the spread of Bolshevism.

**The Rivalry of England and Russia in the Waters of Southwestern Asia.**—England has generally opposed Russia's plans to reach a favorable seacoast because their success might threaten British rule in India. For a long time England feared that war might arise with Russia. If that happened a strong Russian fleet coming out of the Black Sea or from a good base on the Persian coast might close the Suez Canal, cut England's communication with India, and cripple the British Empire. For that reason England for many years supported Turkey, and insisted that Russia and the other Great Powers sign a treaty which agreed that in time of war the Bosphorus and Dardanelles should generally remain closed to the passage of all warships except those of Turkey. For the same reason England used every possible means to strengthen her influence in Persia. The Great War and the common enmity against Germany, however, converted this rivalry of England and Russia into friendship. Now the internationalization of Constantinople and the collapse of Russian ambitions for expansion have freed England from all fear of Russia by sea.

**How England's Relation to the Sea has Spread British Investments Worldwide.**—England's relation to Russia is only one phase of her interest in sea power. Her activity by sea has not only given Great Britain the greatest colonial empire, but has led the British to make investments in every corner of the world. Before other great nations were ready to do so she was able to carry the world's trade and thereby built up great fortunes from the profits on freight. Because she had surplus capital from those sources and from her manufactures and also because her abundant means of communication by sea kept her in touch with all parts of the world British capital has been invested in all kinds of enterprises from Cape Horn to Alaska and from New Zealand to Norway. These investments keep her permanently interested not only in her colonies, but in every other part of the world, and thus give the British a broad interest in world politics quite different from the provincial interests of most people who live far from the sea.

**Germany's Challenge of British Sea Power.**—Great Britain and Russia are not the only nations that appreciate the value of supremacy upon the sea. Germany's eagerness in this respect was one of the causes of the Great War. Cramped and overcrowded conditions in Germany because of the rapid growth of population and the limitations of the frontiers led the whole country to agree with the far-seeing Bismarck when he said, "The future of Germany lies upon the sea." A great merchant marine was rapidly built, and a large navy to protect it. At the same time an attempt was made to obtain colonies and to foster foreign trade. Such activities aroused British jealousy. The English know that the strength of their empire depends upon the protection of the lines of communication between the island center and the great dependencies in all parts of the world. If any other power or combination of powers should overcome the British navy, the Empire would crumble to pieces. The fear that Germany might in time be strong enough to bring about such a result was one reason why England gave up her hostility to Russia at the beginning of the present century and joined with that country and France to form the *Triple Entente* as a balance to the *Triple Alliance* of Germany, Austria, and Italy.

In the past the great nations of the world have divided the land among themselves. To-day they are also taking the sea under their dominion. Thus methods of using the sea are beginning to play a large part in the political discussions of many countries. Japan, for example, as well as Russia, England, and Germany is keenly desirous to gain wealth and influence from the sea. This is natural in view of her island character. The example of all these countries and the need of abundant ships during the Great War has led the United States to build not merely a strong navy, but a great merchant marine. Otherwise we should have been in danger of losing much of our influence.

(4) *The Ownership of Minerals as a Political Problem.*—In some countries such as England the owner of a piece of land is supposed to own everything from the surface down to the center of the earth. In other places, such as many of our Western States, he owns the soil, the water, the stones, and all the rights that are needed for agriculture, house-building, or other ordinary pursuits, but does not own the minerals that are extracted by mining. They belong to anyone who discovers their presence and files the proper claims. In still other regions such as Argentina, Italy, Germany, and Mexico, the minerals belong to the state, and can be mined only on proper payment to the government.

Many thoughtful people think that in our own country this last system should be followed, since they believe it is not right that a man should make millions simply because he happens to be able to file a claim to a mineral deposit, while another who works harder and with much more intelligence makes only a fair living. Hence the Government has withdrawn large areas of mineral lands, that is, it has said that for the present they shall not be granted to individuals. In both this country and England there has been much agitation for the nationalization of the coal mines. The supporters of this idea say that minerals like coal and petroleum are so important and so easily exhausted that the State ought to guard them. Others say that government ownership would be unjust and would cause the mines to be worked inefficiently and wastefully. Some people take a middle ground and say that the best plan is that the government should own the mines, but should allow private companies to operate them on the payment of a royalty or percentage of the profit. These differing views cause the ownership of minerals to be an important political question not only in the United States, but in England and elsewhere.

**Why Black England Wants Free Trade and Green England Protection.**—The *soil and minerals* of England have given rise to one of the chief political problems, a problem which has agitated the country for a century and is not yet settled. "Black England" is the smoky industrial and mining section located chiefly in the uplands of the center, but running from Cardiff in South Wales to Yorkshire in the north. There minerals are the chief source of wealth. "Green England" is the agricultural plain of the east and south where the soil is the chief source of livelihood. The greatest need of the manufacturing and mining population is an abundance of cheap food. Therefore Black England is eager for free trade, so that it may import food without paying duties. On the other hand, the farmers and landowners of Green England see the matter quite differently. They cannot compete with the wheat of the great plains in countries like Canada, Argentina, and Russia. If they could impose a duty on imports of food, however, the price of agricultural products would rise, and the owners and tillers of farms would prosper. Hence the slogan of Green England has been "Protection and Prosperity." Thus the contrast between the minerals of Black England and the soil of Green England has often led to a main line of cleavage between the two chief British political parties. The consequent tariff problem can never be solved to everyone's satisfaction, for the minerals and the soil will always lead to diversity of interests and hence to differences in politics. Since manufacturing and mining, however, employ many more people then agriculture, free trade is likely to continue as it has for several generations.

(5) *How a Difference of Climate led to the Civil War.—Climate,* like other geographical conditions, has a strong effect upon political relations. The climate of the Southern States causes them to be one of the best places in the world for the highly profitable crops of cotton and tobacco. Strange as it may seem this fact has in one way been a decided disadvantage for it lead to the introduction of negro slavery. The early settlers soon found that they could make great profit out of tobacco if only they had laborers, and when cotton became still more profitable the need of laborers increased. Since white people of the Northern races generally become sickly if they work much out-of-doors in the South, especially in summer, owners of large farms or plantations began bringing black slaves from Africa.

No one then thought this wrong. In early days slaves were held among the Puritans of New England as well as among the people of the South. In the North, however, slave labor did not pay. To get a living from the soil demanded hard, steady work, for which the slaves were not fit. A slave ate as much as a white man, and wasted much more. In the Northern States it was actually more profitable to hire a white man than to own a slave. Hence slavery did not long survive.

In the South, on the contrary, slavery was profitable. The white man was not at his best because of the long summer. A slave, however, could do more than in the North because there was no severe winter to hinder him. In the Southern climate even the labor of an inefficient slave furnished more than enough to support himself and his family, and the work of other members of the family swelled the profit to the owner. This was especially true when the prices of tobacco and cotton were high. Therefore, in the South slavery persisted.

While slavery thus became entrenched in the South the world was gradually becoming convinced that human slavery is wrong. This conviction easily spread in the North but failed to make headway in the South since the people were blinded by their great profits. Hence for a time Anti-slavery and Pro-slavery dominated the politics of the whole country and finally brought on the Civil War. That terrible struggle would never have occurred but for the marked climatic contrast between the North and the South. Even to-day the political divergence arising from the difference in climate between the North and the South still persists in the fact that the Democrats count on the vote of the "solid South," while the chief strength of the Republicans is in the North.

(6) *How Geography Dominates the Tariff Question in American Politics.*—Many people suppose that they believe in free trade or protection because of principles of general justice. The vast majority, however, hold one belief or the other simply because of the place where they live or the occupation that they follow. The *plants and animals* that grow in a place or are used in its industries influence our beliefs far more than any amount of theoretical argument.

As a congressman once put it: "We are not patriots in our treatment of the tariff. We forget the good of the country as a whole, and think only of what products we want free or protected because of the geographical conditions in our particular part of the country." The following examples of things that have actually happened in Congress when a tariff bill has been under discussion illustrate his words. (1) A Massachusetts Republican, although belonging to the party that advocates protection, demanded that hides be placed on the free list. He came from a shoe manufacturing region. At the same time a Texas Democrat whose party believes in free trade, insisted that the duty on hides be increased. The plains of Texas are excellent for cattle, and a high duty on hides would increase the price of their skins. (2) A South Carolina Democrat demanded a protective duty on rice. (3) When the tariff on sugar was reduced by the Democrats the Louisiana Democrats and the Michigan Republicans, representing cane sugar and beet sugar, united in opposing the measure tooth and nail. (4) Senators from the Rocky Mountains dwelt upon the importance of protection of wool. (5) The representatives from California demanded protection of lemons. (6) Minerals have the same effect as plants and animals. For when the Republicans voted for free coal a Pennsylvania Republican declared that this was a repudiation by his party of its policy of protection.

In general each part of the country wants protection and high prices for the things that it produces, and free trade and low prices for the things which it must bring from elsewhere. Manufacturers generally want a tariff on manufactured goods and free trade for raw materials and food. The rich agricultural States of the Mississippi Valley generally want low duties on manufactured goods and high duties on food. The Southern States in general favor free trade because they bring practically all their manufactured goods from a distance. Free trade does not alter materially the price of their one large export, cotton, because other parts of the world have not enough to export to America.

**How the Monroe Doctrine has Sprung from the Isolation of the New World.**—The Monroe Doctrine, like the whole problem of boundaries, depends on a number of geographical conditions. According to this doctrine no nation outside of America is allowed to obtain new territory in the Western Hemisphere or to establish a new government over any part of it. The United States took the lead in this movement of America for the Americans partly because this country is located in the most stimulating climate of the New World. We were able to maintain it partly because the wide Atlantic separates the Americas from Europe. The Monroe Doctrine was first declared in 1823 when the South American countries had revolted from Spain and were establishing republics. At that time there was danger that European countries would take possession of South America as they later took possession of Africa. The United States did not wish this, for the people here believed in self-government and wanted those of South America to have an opportunity to try it for themselves.

If South America had been as close to Europe as is Africa, this country could not have prevented England, Germany, France, and other European powers from taking parts of Latin America. So much time, expense, and danger, however, are involved in transporting an army across the sea that no European power thought it worth while to go to war with us in order to obtain colonies. Thus South America was left to try its own experiments in self-government.

Through the Monroe Doctrine we have as it were, pledged ourselves to see that the experiment of self-government has a thorough trial. This, however, places on us a heavy responsibility. Judging by India, Egypt, South Africa, and other British colonies as well as by

French Tripoli and the Dutch Islands of Java and Sumatra, the more tropical portions of South America would to-day be better governed, more prosperous, and more peaceful than at present if they were held by such an enlightened colonial power as Britain. Therefore because the sea has enabled us to say "Hands off" to Europe we are bound to see that no part of Latin America is the loser on this account. We do not want to govern the Latin Americans or take their territory. To do so would be a burden to us and would prevent them from learning through experience. We should be equally careful not to exploit their wealth selfishly, although it is inevitable that the development of their resources should come largely through foreigners.

Without governing or exploiting the backward parts of the Western Hemisphere we can help them in a thousand ways. We owe it to them and to the rest of the world to see that they have stable, just governments, such as we are trying to support in Cuba. We can serve them greatly by teaching them to observe the difficult laws of health and sanitation, as at Panama; we can do much by means of schools and education to arouse them from the inertia which is so common in tropical climates, as many missionaries are doing in Mexico; we can assist in improving their homes, their business methods, and all the other factors which make up a healthful, vigorous civilization, as a great American fruit company is doing in Guatemala, Costa Rica, and elsewhere. We need not expect thanks for all this, yet we must do it not merely because in the long run it will be best for us as well as for them, but because the presence of the sea has caused us to establish the Monroe Doctrine and thus to take upon ourselves the protection of the weak and the oppressed on this side of the Atlantic.

**The Relation of Geography to Political Boundaries: The Value of Mountains as Political Boundaries.**—Many political effects spring from a great variety of geographical causes. Boundaries, for example, depend on land forms, water bodies, soil, minerals, climate, vegetation, and even on the distribution of animals. Mountains determine political boundaries more often than does any other geographical feature except the seacoast. This is because they possess a number of distinct advantages: (1) They form barriers which naturally separate the people on the two sides; (2) a mountain boundary usually lies in unoccupied lands which have no great value; (3) the crest of a mountain range is usually well defined, so that there is little question as to where the boundary lies; (4) such a boundary is not subject to changes like those of rivers.

Spain furnishes one of the best examples of the political value of mountain boundaries. The Pyrenees, which cut it off from the rest of Europe, are so hard to cross that throughout much of its history Spain has been quite separate from central Europe. The mountains were one of the chief reasons why Spain played so little part in the Great War. Italy, also, is cut off from the rest of Europe by the Alps. Accordingly no armies except those of two of the world's most daring generals, Hannibal and Napoleon, have ever crossed the main chain of the Alps. Only at either end where the Alps descend to mere foothills can they be crossed with comparative ease and even there the railroads need tunnels. Yet in the past armies from France and especially Austria have sometimes gone this way to Italy.

**How Good Political Boundaries may be Bad Commercially.**— It is important to realize clearly that the *political* effects produced by geographical conditions may be good while the *commercial* effects may be decidedly bad. For example, politically a country is fortunate if its boundaries are sharply defined by high mountains and are not easily crossed. Commercially such boundaries are unfortunate, for they hamper transportation and trade. India and China illustrate the matter. They are separated by the great barrier of the Himalayas and various other mountain ranges. This has been an advantage politically because it has prevented wars. It has been a great disadvantage commercially, however, for it has almost prevented commerce. It has also prohibited the interchange of ideas and has thus hampered the progress of civilization.

**Why Artificial Boundaries are a Disadvantage.**—Wherever international boundaries fail to coincide with natural barriers, trouble is apt to ensue. For example, the southern boundary of the United States is marked in part by the Rio Grande, but farther west it traverses the open plateau. Even the Rio Grande loses its value as a barrier in dry weather, for then it can easily be forded at many points. The rest of the boundary is marked only by pillars set so that one can be seen from the other. Only in a few sections is it followed by a high barbed-wire fence built in order to prevent cattle from straying or being driven across the boundary in defiance of the customs regulations. When Mexico is in commotion, as frequently happens, there is nothing aside from a shallow river or an occasional fence to prevent armed raiders from crossing into the United States. In 1916 a notorious raid of this kind occurred at Columbus, New Mexico. American civilians and soldiers were killed by Mexican bandits. American troops were sent into Mexico and stayed for months, and war between the two countries was averted only with great difficulty. All this would never have happened if the two countries had been separated by a boundary which is also an effective barrier.

**Unfortified Boundaries.**—The only effective method of avoiding trouble along an international boundary where there is no natural barrier is that which prevails on the northern border of the United States. From the Great Lakes westward our northern boundary runs across plains, mountains, and rivers with no regard to natural features of relief. It is as easy to pass from one country to the other as to travel within the limits of either country. Fortunately because of the friendship growing out of similarity in race, language, and ideals, Canada and the United States have agreed that neither will ever fortify the boundary or make any preparation for military activity along its course, nor will either power have warships upon the Great Lakes. This agreement is rigidly carried out, yet frequently small disturbances occur because evil doers cross from one side to the other. During the Civil War, for example, Canadian sympathizers with the Southern Confederacy tried to organize an armed expedition to cross from Canada into the Northern States. Half a century later, during the early part of the Great War, German sympathizers from the United States crossed the boundary and tried to injure Canada by blowing up the Welland Canal and the international bridge across the Saint Croix River.

Sweden and Norway furnish another example of unfortified boundaries. They have agreed that a strip within 15 kilometers on either side of the international boundary shall form a "buffer zone" where neither power will erect fortifications. The same sort of agreement has been entered into between Siam and Burmah.

**How Germany's Frontiers Helped Bring on the Great War.**—Among the world's great nations Germany has politically the most unfortunate boundaries. An understanding of them helps to explain some of the causes of the Great War. The really bad sections of Germany's boundaries are on the east and west. The eastern boundary crosses a featureless plain, while the Dutch boundary on the west is of the same kind. The pre-war boundary toward Belgium and France lay mostly in a region of low hills easily traversed. Commercially such boundaries would be good were it not that they gave Germany the mouths of the Niemen and Vistula Rivers which naturally belong to Russia, and cut Germany off from the mouth of her most important river, the Rhine, where the chief German seaport would naturally be located.

The indefinite character of her eastern and western boundaries was one reason why Germany encroached on her neighbors. In the eighteenth century she annexed part of Poland, and in the nineteenth took Alsace-Lorraine from France. France naturally wanted to recover Alsace-Lorraine, for in that region the majority of the people are French in race and in sympathies. Except along the Vosges Mountains in southern Alsace there are no physical boundaries to separate it from France any more than from Germany. Therefore both countries felt obliged to provide military defenses along Germany's western boundary. In the same way on the east Russia and Germany were not physically separated. Before the Great War they had no agreement like that between the United States and Canada. Moreover such an agreement is difficult because the two countries differ greatly not only in language and habits, but in ideals and purposes. Each has constantly been afraid of encroachment by the other.

Even in times of peace the absence of any distinct barriers on the east and west of Germany caused difficulties. The Poles by the hundred thousand went from Russian Poland into eastern Germany and took the place of German workmen who had moved west to the great manufacturing districts or migrated to America. Thousands of Germans went into the Baltic provinces of Russia and there became a dominant force. These things made Germany feel that her power was declining in the southeastern part of her own country, while at the same time she was losing her own citizens elsewhere. On the west the Germans felt hampered and hemmed in because the great volume of foreign commerce that came down the Rhine had to pass through the hands of the Dutch who control the lower Rhine. In the same way the Belgians profited because much of Germany's foreign commerce that was borne by rail passed through their territory. The discontent caused by these conditions was one reason why Germany was so ready to go to war.

**The Character of the Present Boundaries of Central Europe.**— From the purely physical standpoint the present boundaries of central Europe are little better than the old ones. Germany's boundaries have the same disadvantages as before. The Rhine indeed is geographically far less of a barrier than the Vosges Mountains. On the east the boundary everywhere traverses a level plain and can easily be crossed at any point. The only advantage is that the new boundaries satisfy the racial aspirations of more people than did the old, while the League of Nations intends to prevent the building of fortifications along any frontier.

Poland's boundaries are politically even worse than Germany's, since that country is carved out of an open plain. In fact the lack of any barriers between Poland and her neighbors was one of the main reasons why the old Poland of a century ago was divided between Germany, Austria, and Russia. In the future the lack of barrier boundaries may foster Poland's trade, but will cause the Poles in different sections to want to enter into intimate relations with their respective neighbors and may cause strong political differences.

Czecho-Slovakia, Jugo-Slavia, Hungary, Austria, and the other little states of that part of Europe suffer more or less in the same way from lack of definite physical barriers in the places where racial distribution causes the location of boundaries. Because of this fact great tact and wisdom are needed on the part of the League of Nations to prevent further troubles like those of Poland, Austria, and the Balkans in the past.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. On an outline map of the United States, color all the boundaries both state and national, according to the following scheme: (*a*) boundaries determined by mountains—red; (*b*) by water—blue; (*c*) by deserts—yellow; (*d*) by arbitrary lines of latitude and longitude or other straight lines—green. Discuss your map to show what parts of the country are characterized by each kind of boundaries, and why.

2. Make a boundary map of Europe like the one for the United States described in Exercise 1, and discuss it in the same way. Write out a statement of the chief points of contrast between the maps of the United States and Europe, and their reasons.

3. Prepare a map showing the present boundaries of European countries compared with those previous to the Great War. Discuss the geographical conditions which determined the location of each new boundary. Show the effect of (*a*) mountains; (*b*) distribution of races; (*c*) routes of transportation; (*d*) arbitrary exercise of power.

4. Look up the climatic graph for Vladivostok (Fig. 84) and point out what features of it have had an effect on international relations and how.

5. On an outline map of European Russia and Siberia, color the coasts which are icebound in winter. Insert the Trans-Siberian and Trans-Caucasian railways with their main branches and connections to foreign countries. Draw lines along the four most feasible routes by which Russia and Siberia might find outlets to the ocean on the south. Describe each route from the following points of view: (*a*) topography; (*b*) climate; (*c*) location in respect to well settled parts of the Russian Empire; (*d*) difficulty of building and operating lines of communication; (*e*) international relations.

6. It has been said that the great area covered by the United States presents real community of interest. Prepare both pros and cons for a debate on this question.

## CHAPTER XXII

## INTERNATIONAL RELATIONS

**How the Strong Nations Have Expanded.**—One of the chief political questions of the twentieth century is the relation of strong nations to those that are weak or backward. Geographical conditions, as we have already seen, strengthen some nations and weaken others. Hence such conditions have a profound influence on international relations and so on the ideals which are one of the greatest factors in advancing or retarding civilization. History shows that strong nations in invigorating climates almost inevitably expand and dominate the weak ones in less favorable climates. In the past they did this without restraint, but now their expansion is more or less controlled by the concerted action of other nations.

The direction in which strong nations expand depends on geographical conditions. As a rule a strong nation gradually expands into adjacent territory that is either sparsely populated or poorly governed. At first the expansion is more or less accidental, or at least is merely the work of individuals, but later it is guided by definite purposes, which become part of the national ideal. Let us trace the expansion of each of the great powers, so that we may understand both *how* it has taken place and *why*.

**(1) Great Britain. How Britain Expanded Across the Sea.**—The earliest attempt of Britain to expand beyond the limits of the British Isles was directed toward France, but as that country, according to the standards of those early days, was neither sparsely populated nor poorly governed, England was baffled. Then Britain turned her attention across the sea. Spain, Portugal, and France, however, the other three main countries on the side of Europe toward the Atlantic, were also looking for opportunities across the water. Spain and Portugal, in accordance with their geographical position, found their sphere of activity in low latitudes where the mild climate prevented their colonies from growing great. England and France colonized farther north, where the climate is stimulating. The fact that England is an island, and looks seaward, while France is part of the continent and is more interested in the land than in the sea, helped the English to wrest from the French their possessions across the seas. Thus by far the best part of America became English.

During the early days the English had no idea that some day their colonies would expand into the great Dominion of Canada and the still greater United States of America. The fact that the colonists lived in a highly stimulating climate, however, made such expansion inevitable. That same fact also had much to do with the separation of the United States from England, for energetic people will not tolerate abuses which more apathetic people put up with for centuries.

In India the effect of geographical conditions upon England's colonial history was very different from the effect in the United States. Soon after the discovery of America British merchants went to India to engage in trade and with no purpose of founding a vast Indian Empire. They found a densely populated country whose inhabitants lacked energy because of the tropical climate, and who were correspondingly backward in civilization. Accordingly, for their own convenience and safety, the British merchants assumed control of a small area near Calcutta and governed it. At first they merely took space enough for forts within which to shelter their warehouses and offices. Then, for greater peace of mind, they spread their power over the towns where the forts were located and in time over surrounding districts. But neighboring Indian states troubled them. Sometimes the trouble was due to the aggression of the forceful English traders; sometimes to the dishonesty and treachery of the natives. In either case the strong people from an invigorating climate conquered the weak tropical people. Thus British rule was spread abroad. The process has continued until England governs over 300,000,000 people in southern Asia.

During the Great War the location of Mesopotamia and Palestine gave England a special interest in those regions. Germany had been encroaching on Mesopotamia, and thus bade fair not only to dominate the land route from the Mediterranean to India, but to threaten the sea route. Turkey, on the other hand, began to threaten the Suez Canal from Palestine. Hence England conquered not only Mesopotamia, using India as her base for supplies and troops, but Palestine with Egypt as a base. When peace was declared England was left in control of these regions and in a position to carry out her long-cherished plan of a land route of her own from Egypt and the Mediterranean to India. Outside her actual possessions the influence of England is paramount in Persia, Afghanistan, and Tibet, because her position in India makes her the nearest strong power to each of them.

In the Southern Hemisphere British expansion followed much the same course as in the Northern. Australia, with its sparse native population and its good climate in the southeast, repeated the history of North America on a small scale, as did New Zealand. There was never any revolution, however, because England learned the lesson of good colonial government from her war with the American colonies. In South Africa the course of events was midway between that in Australia and India. The British settlers encountered a denser native population and a less stimulating climate than in Australia. They dominated the natives as in India, but they themselves have gradually been weakened so that progress is not so rapid as in a place like New Zealand. In tropical Africa the conquest of the British Colonies took place much as in the later stages of India's history, but the results have been relatively meager. Elsewhere the British colonies are relatively small or unimportant. In Egypt England acquired a colony because Egypt happens to lie on the highly important route which connects the homeland with India. But in 1922 England gave up her direct control over Egypt except for a canal zone where her position is much like that of the United States in the Panama Canal Zone.

**Why the British Empire Has Grown so Great.**—(a) *Britain's Central Location.*—The reasons why the British Empire to-day embraces nearly a quarter of the earth's surface may well be classified according to the table in Chapter I, showing the elements of geography. The location of Britain off the northwest coast of Europe brings it nearer to the middle latitudes of America than is any other country of Europe. This is important because Britain was thus led to occupy the best part of America. That helps to explain why English is the most widely used language. The location of Britain in respect to India was also influential in causing the Suez Canal to be dug, and was the reason why England took charge of Egypt and still controls its foreign policy. After Great Britain became imbued with the purpose to build up a great empire she set herself to control the best lines of approach to each of her possessions. This involved picking up islands like the Bermudas, and Falklands, and ports like Hongkong all over the world. To-day along her most important route leading to India England has secured a whole string of way-stations, including Gibraltar, Malta, Cyprus, Suez, Perim, Aden, Socotra, and the Kuria Muria Islands. Thus Britain is the meeting place of the most remarkable network of lines of communicaton that the world ever knew. She has improved her own location even though it was already highly favorable.

(b) *The Advantage of the Empire's Island Home.*—England is fortunate that her land takes the form of an island, and particularly of an island with a submerged coast. Had her territory been joined to that of the mainland she might perhaps have remained united with France as a single nation. Certainly her interests would have been directed toward the continent as have those of France because of the need of protecting herself from other countries and of maintaining constant intercourse with them. Had her coast not been submerged she would have lacked the hundreds of harbors, great and small, that keep her in touch with the sea. Moreover, when she came in conflict with other nations which were also expanding by sea she had an advantage because her long coast gave her far more sailors and ships than had the others, and also led her people to be interested in commerce and remote overseas ventures in a way that is not possible for an inland country.

(c) *How the Ocean Brought Worldwide Expansion.*—Being surrounded by water Britain had to expand by sea or not at all. Since she expanded across the water she was able to choose whatever places she preferred with much less hindrance than if she had tried to push this way and that by land. As the most active of the great nations on the sea, she was able to take possession of almost all the best regions in America, Africa, Asia, and Australia. Even when other nations had preceded her, she often drove them out as happened to Holland in New York, to France in Canada, and to Portugal in Ceylon.

(d) *How Coal and Iron Aided the Empire's Growth.*—The minerals of Britain have been of the first importance. An abundance of cheap coal close to the water enabled Britain to substitute steamships for sailing vessels sooner than did any other nation. Then it enabled her to run her ships cheaply and gave her cargoes to take abroad in exchange for bulky food stuffs and raw materials. Thus coal clinched Britain's control of the sea. So having picked up an island here, a seaport there, and a whole province somewhere else, she was able to hold them easily. Her iron ore helped equally, for with the coal it enabled her to become a manufacturing nation sooner than did any other country. Her manufactures supplied her ships with the most profitable kind of goods for export, and thus are one of the main causes of the growth of the empire. Petroleum is the only important mineral product which neither Britain nor her colonies supply. For that reason after the Great War some influential Englishmen wanted to retain Persia and part of Transcaucasia in order to control the Baku oil fields. Others, however, felt that such a course was contrary to the spirit embodied in the League of Nations.

(e) *How British Energy Turns the Scales.*—England, as we have seen, probably has the best climate in the world. It keeps people out doors, and makes them tough and sturdy; it stimulates the mind, and makes it easy to think clearly and act energetically. Thus when the British are pitted against other nations their extra energy has again and again turned the scales and enabled them to hold parts of the world against their rivals. One of the main reasons for the strength of the British Empire is that several of the chief colonies have climates which resemble that of England in their stimulating qualities. Southern Canada, New Zealand, and southeastern Australia, rank highest. No other country has colonies which at all approach these in this respect. Their value is evident from the sturdy help that they gave in the Great War.

(*f*) *How the Need of Food and Raw Materials Forced Expansion.*—From the point of view of a colonial empire it is well that certain useful plants and animals cannot grow in the British Isles, for it was the search for valuable products like tea, spices, and silk, which led to Britain's first expansion to India and America. In later times, when manufacturing became important, the fact that Britain cannot produce either food or raw materials in sufficient quantity and variety impelled the British still further to expand their empire. The jute and hides of India are far more valuable than all her spices, silk, tea, and precious metals. So, too, the wool and meat of Australia, the wheat, wood, bacon, cheese, and paper of Canada; the cotton of Egypt; the rubber of Ceylon; and the wool of South Africa, are the kind of products that make her colonies worth while to Britain.

(2) **The Expansion of Russia.**—Just as England furnishes the greatest example of expansion by sea, so Russia furnishes the best example of expansion by land. Compared with the 13,000,000 square miles and 440,000,000 people of the British Empire, Russia, before the Great War, had 8,600,000 square miles and 180,000,000 people. Yet the Russian Empire had little of the strength and vigor of the British, for Russia and Siberia are subject to many geographical disadvantages.

(*a*) In *location* the Russian Empire had the disadvantage of being in the worst part of Europe and in the least accessible part of Asia. Thus it came in little contact with the world's most progressive countries. It had the advantage, however, of being a single compact mass instead of a vast number of isolated and vulnerable parts such as compose the British Empire.

(*b*) The *form of the land* in Russia courted expansion, for in the great portion between the dense northern forests and the southern deserts the vast plain is easily traversed. From Moscow, where the empire began, the plain stretches away in every direction. To the north it finally reaches a boundary only in the Arctic Ocean, and to the south in the Black Sea and the Caucasus Mountains. Westward the Russian Empire never reached any natural boundary, for before the form of the land changes appreciably, new races are found and new conditions of climate and vegetation. In this lay much of Russia's weakness, for when the Empire began to crumble these border regions at once broke into minor principalities like Finland, Poland, and Ukraine. Eastward the plain is only slightly interrupted by the low Ural Mountains and extends thousands of miles to the plateaus of northern Siberia. Its vast extent was one chief reason why the Russian Empire became so huge.

(*c*) As we saw in the last chapter Russia has always been handicapped by her unfortunate *relation to the oceans*. So far as *inland bodies of water* are concerned, however, her expansion has been helped. Because Siberia is a plain the pioneers in that country were able to float down one river and pole their boats up another time and again. Such water transportation aided greatly in allowing the Russians to spread easily over northern Asia.

(*d*) One of the important points where Russian expansion differed from that of Britain was the use of minerals. In Britain coal and iron are found near the most densely populated parts of the country. In Russia, the deposits are not only far less abundant than in England, but lie largely on the outer edges. For these reasons and also because Russia is in many respects less advanced than the other great powers, her coal and iron have done little to help in the development of manufactures. They neither caused the empire to expand, nor prevented it from falling apart under the shock of war and revolution.

(*e*) Although western and central Russia have a highly stimulating *climate*, it deteriorates along every possible line of expansion. This made it easy to conquer the people of outlying regions, but it denied to Russia the chance to develop strong colonies like Canada and New Zealand, which in some respects excel the mother country. On the contrary the farther Russia expanded toward the south, east, and north, the less became the energy and power of the people, and the weaker their union with the central government.

(*f*) Another disadvantage appears in the *plants and animals*. England's expansion enabled her to draw on all sorts of new food stuffs and raw materials. That of Russia in early days, to be sure, brought her the rich wheat fields of the south and of western Siberia, but in later times she acquired nothing new—merely more of the old kinds, but of poorer quality. Hence there was no great stimulus to trade, and little incentive to improve the difficult means of communication between the outlying regions and the center.

**Russia's Great Handicap, Monotony.**—To sum up the whole matter, although some great minds like Peter the Great made plans to attain definite ends such as an outlet on ice-free seas, most of Russia's growth was largely accidental. The more energetic people of the western and central parts pushed out over the plains much as the British pushed out across the water. Quarrels with the natives ensued. The government stepped in to protect its citizens, and the result was an enlargement of the Russian Empire. Yet the cold climate and the consequent sparsity both of people and of materials for commerce prevented the Russian Empire from being tied into a great net as is the British Empire, and so it fell to pieces. The pieces may ultimately form parts of a new and happier Russian Empire, for the unity of the language and the unity of the vast plain strongly tend to hold the country together. But such an empire can scarcely hope to rival those of the United States and Britain whose territories are blessed with a variety which is a potent source of strength. Compared with such a country as the United States Russia is handicapped by intense monotony. The plain shows it; the climate shows it; the plants and animals show it; and so do the people.

(3) **The Expansion of the United States.**—Because our own country is a region of high energy and is inhabited by a strong race the process of expansion has gone on rapidly. We bought Louisiana and Alaska because they are located nearer to us than to any other strong power. Hence they were worth more to us than to France or Russia, their previous owners. Two other geographical conditions also entered into the matter, namely the fact that Louisiana guards the mouth of our greatest waterway, while Alaska is rich in fish and fur. In the cases of Texas, New Mexico, Arizona, Nevada, and California location was also a primary factor in causing the expansion of the United States. In Texas, however, the form of the land and the nature of the climate were important. The great plain, continuous with that of Louisiana, invited settlers, while the fitness of the climate and vegetation for the raising of cattle were strong incentives. The other States fell into our hands largely because so much of them was desert and the parts that were not desert were so far from Mexico that few Mexicans lived there and misgovernment was rampant. Hence in spite of much talk, there was little organized opposition in Mexico when they were ceded to this country. Although the whole transaction was to the advantage of Texas and the United States, it was not strictly just. It illustrates the way in which the demands of the energetic people of cyclonic regions are forced upon the weak people of the tropics and the Orient. It must also be remembered that by reason of its own natural growth and the addition of settlers from Europe, the United

States was rapidly expanding, while Mexico was changing but little. Mexico herself, together with the unfavorable climate, prevented us from expanding southward, while England was firmly established in Canada. Hence the natural direction of expansion was westward. This explains why the settlers of the United States pressed into Washington and Oregon ahead of the British, who claimed those regions because of their fur-trading posts. Our other acquisitions also illustrate the effect of climatic contrasts and of location. At first our expansion, like that of Russia, was entirely by land, but later we followed England's example and went across the water. First we took the Hawaiian Islands because they are nearer to us than to any other country. Moreover, although not on the main route between this country and Japan and China, they are a port of call for many steamers. For these reasons and also because of their wealth in cattle, sugar, and other tropical products Americans already formed a solid nucleus for self-government and we felt obliged to support their aspirations to become part of our union. In Samoa, also, we took action, first because we wanted a naval station in the South Pacific, and then to prevent misgovernment.

After the war with Spain in 1898 we placed a protectorate over Cuba. Because it lies at our very door we were interested in its sugar crop, and wanted to right its wrongs. Our acquisition of the island possessions of the Philippines and Porto Rico, however, had little geographic cause except in so far as Spain's weakness and corruption were of geographical origin. As for Guam, we were glad to get it because of its location where a coaling station was needed if we were to maintain much intercourse with the Philippines. Since then we have annexed the Panama Canal Zone and have established a mild protectorate over the Republics of Panama, Nicaragua, Haiti, and Santo Domingo. We have not done this from any desire for expansion, but simply because our location near these countries has obliged us to use our strength in forwarding the great international enterprise of the canal and in protecting our own people or others from the misgovernment of weaker countries. The Virgin Islands fall in a group by themselves. We bought them from Denmark because the United States is coming to feel that it should not run the risk of letting islands guarding the approaches to Panama fall into unfriendly hands.

(4) **The Expansion of France.**—France is another of the countries located in a region of highly stimulating climate. She, too, has expanded into regions occupied by weaker people, but not in the same way as Britain, Russia, and the United States. She has not had much surplus population with which to establish colonies like those of

Britain. Her frontiers, unlike those of Russia, have been bordered by strong countries so that she could not expand into neighboring territory. Soon after the discovery of America she made her first colonial attempt in the same way as Great Britain. Many of her people settled in Canada, and Louisiana, and India. These places she lost, chiefly to England, because of the English energy and sea power and because being a self-supporting agricultural country with no excess population she did not really need colonies. All that she holds to-day in these regions is a few tiny bits like the islands of St. Pierre and Miquelon off Newfoundland and the port of Pondicherry in India. In thus losing her early American and Indian colonies France suffered the same fate as Holland and Portugal.

During the nineteenth century, when the need of raw materials and of markets started all the great countries of Europe on a new hunt for colonies France again made an attempt. This time she did not expand from her Atlantic coast where she had failed before and where she would have had to compete with England. Instead she went out from her Mediterranean coast to Tunis and Algeria, the nearest land that was not held by a strong nation and hence was weakly governed. Then she expanded into the Sahara and eventually took the bulk of west Africa. To-day her possessions in the continent of Africa are twenty times the size of France, while even the island of Madagascar, off the southeast coast, is larger than all of the home country. Finally the French turned again toward Asia, and there, unlike Great Britain, they entered upon a deliberate plan of conquest in Indo-China. To-day the French possessions are larger than the United States and have half as great a population. England alone has a larger colonial empire. Strangely enough all this territory is commercially tributary to the Mediterranean coast of France, and although Paris is the capital, Marseilles is the great colonial port.

(5) **The Expansion of Japan.**—Among the nations of Asia Japan is the only one which is strong because of its location in a region of cyclonic storms. The example of other strong nations convinced her of the value of colonies. The growth of her own population made her feel the need of them. The weak and poorly governed regions of Formosa and Korea only a little distance from her coasts gave her the desired opportunity for expansion. They were not enough to satisfy her, however, and as Manchuria is the nearest easily accessible region she expanded rapidly there.

Japan's expansion is the result of a real need. Not more than one-fifth of her territory can be cultivated because it is so mountainous. That fifth, comprising only 21,000 square miles, supports 55,000,000 people, or 2500 to the square mile. As the population increases and the standard of living rises, the Japanese must have new means of support. They have thought they could obtain these by acquiring new lands, and hence have adopted a policy of attempting to control China. At the end of the Great War, they tried to cling to Shantung, which they had wrested from the Germans, and at the same time acquired new concessions farther south in Fukien.

**How Japan Can Best Solve Her Chinese Problem.**—The experience of France and of most countries that have colonies shows, however, that the real solution does not lie in political control. It lies in cultivating friendly relations so that a profitable trade may develop between countries like Japan and China. In Japan the geographical conditions cause manufacturing and commerce to be of ever-increasing importance. In China the lower degree of initiative among the people and the presence of great natural resources cause that country to offer its chief possibilities as a source of food and raw materials. Political domination of weaker nations by those that are stronger is needed only to prevent misgovernment. It is needed in China far less than in India.

Warm friendship promotes trade far more than political domination, as we have found through our treatment of Cuba. Yet the greatest of all incentives to trade is geographical location. Countries that are near together are sure to carry on a lively trade, especially if one supplies food and raw materials and the other supplies manufactured goods. France and Germany prove the power of geographical position, for even though they are mutually hostile and differ only a little in their products, French trade with Germany before the war amounted to as much as the trade of France with all her colonies. In the same way, in proportion to the population Canada does several times as much business with the United States as with Great Britain. Thus it appears that if Japan remains on friendly terms with China without political control she can some day be the chief factor in the trade of that country, and at the same time maintain the world's respect. In some ways the relations of those two countries are similar to our relations with Mexico, although China is better governed and more advanced than Mexico.

(6) **The Expansion of Germany.**—The relation of Germany to its weaker neighbors is different from that of any other country. She was so busy with attempts at unifying her own states that she was not ready to look abroad until after the formation of the German Empire in 1871. After that she gradually formed the purpose of building up an empire outside Germany. Just as England's purpose was the formation of a great empire of self-governing dominions, and as that of the United States was the spread of self-government and

liberty to people who were oppressed, so Germany's great idea was that she should rule the world by land and by sea.

Among all the Great Powers Germany is the only one that has had no real opportunity to expand either to adjacent territory or to territory lying just across neighboring seas. Landward she was hemmed in by France, Austria, and Russia, all of which were then strong and were in the process of expansion. In part she was also hemmed in by the little nations of Denmark, Holland, Belgium, and Switzerland which, though small, are too energetic to be fields for expansion, as Germany found to her cost in Belgium. She did, to be sure, expand a little, absorbing part of Poland, taking Schleswig-Holstein from Denmark, and Alsace-Lorraine from France. This gained her only a small area, however, and increased the difficulty of farther expansion by arousing antagonism among her strong, energetic neighbors. Expansion by water to the north has been impossible, for Norway and Sweden are as energetic and highly civilized as France and Denmark, and their boundaries are so sharply defined that there can be no possible dispute as to where they lie. Seaward her expansion was blocked by British sea power and by the fact that Britain had already acquired a vast colonial empire before the Germans awoke to the value of colonies.

In distant and backward parts of the world Germany also found it difficult to acquire colonies. In the early days of the modern colonial movement her continental position did not encourage her people to be world-wide traders like the British. Moreover, the many German states were so late in uniting into a strong empire that when at last Germany was able to seek colonies, most of the available territory had already been claimed by other powers. Yet her population was increasing greatly. German manufactured goods were flooding the world, and the country was eager to expand like the other nations of cyclonic regions. Germany, to be sure, obtained a few colonies, such as German East Africa, German West Africa, Kamerun, and part of New Guinea, but they were the scraps left over after the best parts had been taken, and they did not supply the raw materials which Germany so much desired. Nevertheless German expansion was bound to come in one form or another.

(1) It might have come by taking possession of South American regions such as Brazil and Argentina, but there the United States with its Monroe Doctrine blocked the way. Germany knew that if she encroached in America, Britain was ready to use her fleet to help the United States, and German prospects would have been blasted at once.

(2) Germany's expansion might have come by crushing one of her

neighbors, but that was difficult because all her neighbors are energetic nations living in the cyclonic region of great energy. Moreover, they were largely allied with one another, and the larger nations had agreed to protect the small ones.

(3) Next after South America the region that the Germans most desired as a field for expansion was China. Hence they took Tsingtau on Kiau-Chau Bay, and began to exploit the province of Shantung. They dared not go farther, however, for England, France, Japan and Russia all were looking for new territory in China, while the United States was trying to preserve China intact.

(4) Still another possible field of expansion was Turkey, the only remaining large and backward part of the world which no strong nation had yet converted into a colony or at least protected against the aggression of other nations.

(5) German expansion might also have come in the new way which the League of Nations now fosters. She might have spread her influence through the peaceful channels of trade, education, science, and friendly intercourse, especially in eastern Europe and Turkey, just as Japan now has an opportunity to do in China, and the United States in Mexico and South America.

For this kind of expansion the German prospects were particularly bright. She was well on the way to success, but the process was too slow. Ambitious Germany wanted to achieve world supremacy at a single bound. Therefore she chose the fourth alternative, and began to seek to control Turkey. First she went to work to build the Bagdad Railway, from Constantinople across Asia Minor to Mesopotamia. The water route from Germany to Turkey is long and is at the mercy of England. There is a short and safe land route, however, through Austria and the Balkans. If Germany could control this route together with the Bagdad Railway she would have a direct land route through the heart of the prize that she coveted. The easiest way to work for this was through the Germans of Austria, the strongest element in the old Austro-Hungarian Empire. Hence the Germans of Germany combined with those of Austria to gain control of Serbia, the nearest territory available for that purpose. That led to the Great War, during the first three years of which Germany became supreme not only in the non-German parts of Austria, but in Serbia, Bulgaria, Rumania, and the Turkish Empire.

Thus Germany in a sudden unrighteous outburst and with the infliction of frightful suffering, carried out in three years an expansion like that which Great Britain, Russia, and the United States had accomplished slowly and with far less suffering during many generations. If Germany had accomplished this result by means of peaceful commercial penetration the world would have raised no objections greater than those raised against the expansion of all strong countries. Because she disregarded treaties and did deeds which no civilized people can tolerate, the whole world was against her, and she lost not only her recent ill-gotten gains, but her earlier ones in Denmark and Alsace-Lorraine, and all her foreign colonies.

The final result of the war was closely in accord with geographical conditions. Germany was defeated by the western nations living in the most bracing cyclonic areas. Wherever she was pitted against nations living in regions less invigorating than her own she was successful. After her defeat on the west she could not remain dominant in the Balkans and Turkey because England, France, and Italy are all interested in those regions and can easily reach them by water. In central Europe, however, the war left a number of small new nations, including Austria, Poland, and Czecho-Slovakia. These three, together with a greatly weakened and chaotic Russia, adjoin Germany. The Austrians, being Germans in race and language, sympathize with their fellow Germans. The others dislike Germany, but she is the nearest great manufacturing nation, and the one to which they naturally turn for capital, for engineers, and for the many services which less-developed countries constantly seek from those that are most highly developed. The countries bordering Germany on the east stand just enough behind Germany to look up to her and to let her dominate their commerce and industry. Thus in a limited sphere Germany is now carrying out the commercial method of expansion which she might far more successfully have carried out on a much larger scale if she had not chosen war instead of peace. Like the other great cyclonic nations she is expanding, and her expansion is primarily into the somewhat weaker regions adjacent to her on the east.

**Methods of Colonial Control.**—(1) *Exploitation.*—In the inevitable expansion of the strong nations of the cyclonic regions into other climatic areas four different methods have been pursued: (1) exploitation, (2) absolute control, (3) self government under foreign control, and (4) benevolent regulation. Exploitation consists of taking possession of a country solely to squeeze from it as much wealth as possible. The early Spanish explorers and colonists in Mexico, Peru, the Philippines, and many other places adopted this method. They robbed, oppressed, and enslaved the natives without thought of what would happen in the future. Hence Spain's colonies gave her great wealth for a time, but soon became poverty-stricken and resentful. When she fell into trouble they were quick to throw off her heavy yoke, and Spain in the long run was the loser.

Unfortunately a modified form of this method of exploitation is still common. Individuals from our own country often go to places like Mexico, get hold of the best natural resources, and make fortunes as quickly as possible with no thought of responsibility for the natives. So far as we do this we are harming our own country.

(2) *Absolute Control.*—When the strong nations became convinced that mere exploitation of colonies did not pay, most of them adopted the method of absolute control. The purpose of this is to rule the colony in such a way that it shall yield the largest possible return to the mother country, but shall not be so oppressed that it becomes poorer. This is the commonest method at present. In some form it is pursued by practically all the colonizing powers to a greater or less degree. Where it prevails a nation rules its colonies arbitrarily, and the natives are given little or no share in the government. Fine public buildings are erected to impress the natives with the strength of the government; roads, railroads, warehouses, wharves, and other facilities for commerce are provided; and law and order are carefully preserved. The natives neither understand nor like such methods. Of course the degree to which the rulers control their subjects is not always the same. In the German colonies before the war, for example, everything was subject to the most strict and minute regulations "made in Germany." The French have followed this antiquated method less closely and their subjects are correspondingly better satisfied. The Dutch at first pursued the method rigidly in Java and other places, but like the other colonial powers they are learning that it does not pay. The Austrians tried it in Bosnia and Dalmatia, but it was not successful, and was one reason for the Serbian trouble in 1914.

(3) *Self-Government: (a) The British Method.*—A much better colonial method is that of the British. They have learned this method partly because of the high degree of self-control and will power which has always characterized the people of the British Isles, and partly because their strong colonies in cyclonic regions have taught them some stern lessons. Nations which have only weak, tropical colonies find them so easy to govern that they do not learn to respect the rights of others.

In their dealings with colonies the British emphasize three principles: (1) The government strives for absolute justice. The white man, no matter how superior he may feel, is made to observe the law in exactly the same way as the humblest tropical native, as many a traveler in India has been surprised to discover. Of course some serious mistakes occur, but the British colonial officials are chosen from the best men in the country and are filled with the idea that it is their duty to see that the natives have fair play.

(2) The British colonies have a voice in their own affairs. From her experience with the American colonies Britain learned that this is the only way to prevent rebellion. Accordingly the present British method is to allow complete self-government in the more advanced colonies of Canada, Australia, New Zealand, and South Africa, and a considerable measure in more backward countries like India. So far has this process gone that the four colonies in cyclonic regions not only control their own internal affairs and even levy tariff duties against Great Britain, but have a part in international affairs as is shown by their seats in the Assembly of the League of Nations and their representatives in foreign countries. Even India is fast progressing toward self-government, and already has a seat in the League Assembly.

(3) The British do not attempt to force their own civilization upon the natives, but merely offer it to them if they choose to take it. Hence the natives are not annoyed by minute regulations, and are allowed to live according to their own laws and customs so far as these are consistent with the general welfare.

The result of these three principles of colonial conduct is that millions of people in the British possessions are to-day extremely loyal to the empire. They pride themselves on being British subjects, and even full-blooded Hindus sometimes speak of England as "home." Germany expected that India would rebel during the Great War, but it enthusiastically sent troops and supplies to aid the Allies. Both in India and Ireland, to be sure, certain groups want full self-government, but the vast majority of the British Empire want to retain their connection with the mother country.

*Self-government: (b) The American Method.*—America is trying a colonial method which carries self-government a step farther than in British colonies. Our plan is not merely to *permit* colonies to enjoy self-government when they demand it, but to give them definite training in order to *fit* them for self-government as soon as possible. Our purpose as practiced in the Philippines and Porto Rico is to treat the colonies as good parents treat their children, checking them if they do wrong, but striving earnestly to aid them in their education. As fast as they show themselves fit to take charge of their own government we want them to do so. We only insist that first they must learn. We think that they cannot be truly trusted to manage their own government until they have learned self-control, just as a parent would not leave a six-year-old child to play with a razor.

(4) *Benevolent Regulation.*—In Cuba a new and promising method of partnership rather than control has been established between a strong nation and a weaker neighbor. We have said to the Cubans, "You may govern yourselves so long as you govern properly. If, however, you have a revolution, if you get too deeply into debt, or if in other ways you show yourselves unfit, we shall intervene."

Thus without exploiting the weaker people we are trying to help them forward in civilization. That is the method which has become our ideal. Under the guidance of the League of Nations and under the impulse of worldwide public opinion it bids fair to prevail among all the strong nations who live in the stimulating regions of cyclonic storms. As all parts of the world become more and more closely bound together through the development of transportation, industry, and commerce, the strong nations have ever-increasing opportunities to dominate the others. The world is fast becoming a great family of nations just as our own country is a family of States. If one nation remains poor, ignorant, vicious, misgoverned, discontented, all the nations suffer, just as the whole United States suffers if poverty, illiteracy, crime, violence, or discontent prevail in any of our States. If the world is to go forward rather than backward the strong nations must remember that the more a nation can promote the progress and especially the contentment of other nations, the more it is doing for itself and for the whole world.

## QUESTIONS, EXERCISES, AND PROBLEMS

1. Discuss the expansion of Italy according to the method used for the other great powers. Show how the location and character of the Italian colonies are related to (*a*) the location of Italy; (*b*) the rapidity with which Italy has developed politically and commercially; (*c*) the relative size of the Italian merchant marine and navy compared with those of other countries.

Look up the geographic conditions which led to (*a*) the problem of "Italia Irredenta" (Unredeemed Italy) during the Great War; (*b*) the Fiume question at the end of the war; (*c*) Italy's interest in the eastern side of the Adriatic Sea.

2. Make a map to show the former colonial empires of Spain and Portugal. Write notes on the climate, position, and products of each of the parts. Compare the actual degree of self-government and civil liberty in these regions at present with those in the British dominions of Canada and Australia. What has this to do with the geographic environment? What effect has it on international relationships?

3. Consider the following statements, and write a synopsis of the geographical conditions which explain them:

A. "Newfoundland and Tasmania are two islands each of which has a population of something over 200,000. They are identical in race, language, ideals, and civilization. Nevertheless, the United States is far more interested in Newfoundland than in Tasmania."

B. "France and Germany are near neighbors yet they are bitterly hostile, while the French-speaking Swiss have no hostility toward the German-speaking Swiss."

C. "Similarity of race, language and habits is the foundation of the wonderful loyalty of the English-speaking British colonies toward their mother-country."

D. "The feeling of the people of the United States is much warmer toward Belgium than towards Venezuela because the habits of Belgium and the United States are much more alike than those of the United States and Venezuela."

4. Go over the four statements given in Problem 3, and frame a general statement as to the chief factors making for international friendships and enmities. Separate the factors into geographical and non-geographical.

5. On the basis of your general statement of Problem 4, explain the international relations of the United States with (*a*) Japan; (*b*) Canada; (*c*) Mexico. Examine the volume of their trade with the United States; the number of their citizens in this country; the number and nature of the lines of communication; the habits, languages, methods of government. Prepare a summary of the geographical conditions which are most important in each case.

6. Consider the hostility between Germany and England before the Great War and discuss it in the light of your general statement of Problem 4. Consider in this connection (*a*) position in respect to the ocean; (*b*) opportunities for colonization and for business; (*c*) similarity or dissimilarity of occupations and products by reason of (1) climate, (2) resources, (3) race.

7. Make a tracing of the Rhine showing (*a*) the Dutch part at the mouth and one port; (*b*) the boundaries of Alsace and Lorraine; (*c*) the Valley of the Ruhr and three towns; (*d*) the Vosges Mountains and the Black Forest. Define the boundaries of Belgium and Luxemburg. Discuss the part played in the Great War by the geographic conditions thus shown.

8. On an outline map of the United States apply different kinds of shading to each of the following areas: (*a*) the Atlantic coastal plain; (*b*) the Great Lakes region; (*c*) the Mississippi valley; (*d*) the Pacific coastal regions. Discuss an international problem in which each of these is particularly interested. Show how their interest depends on geographical environment.

9. Make three maps showing (*a*) French expansion into Africa; (*b*) Italian expansion into Africa; (*c*) all the spheres of influence of the United States near the Panama Zone. Point out the resemblances and differences in the expansion of these three countries, and explain them so far as they are geographical.

10. Make maps showing (*a*) the main trade routes of Europe before the discovery of America; (*b*) the main routes after the discovery of America and before the making of the Suez Canal; (*c*) the routes of the present day.

In the light of the maps comment on the commercial advantages of (*a*) England; (*b*) Austria; (*c*) Italy, in these three periods.

11. Find out from the Statesman's Yearbook the ten nations having the greatest trade with the United States. Add the imports and exports together in each case and arrange these nations in the order of their commercial importance to the United States. In parallel columns write notes on their propinquity, climate, chief natural resources, health and energy, manufactures, language, and civilization as compared with those of the United States. Name an international problem in which each is involved with the United States.

12. Why is it that the United States is in such close touch with western Europe while the intercourse between China and Japan is very limited? What strictly geographical factors play a part in this?

13. The international relationships of China are unique. This is partly a matter of racial character and historical development, but geographical conditions enter into it. Describe these conditions and their international results. Among other things consider the following: (*a*) the effect of density of population on China's prosperity at home and on foreign trade; (*b*) China's degree of geographic diversity or uniform'ty, and its effect on both internal and external trade; (*c*) the boundaries of China and their effect on international relations; (*d*) the relatively inert character of the Chinese; (*e*) the position of Japan relative to that of other energetic nations; (*f*) the energy of Japan relative to that of other Asiatic nations; (*g*) the resources of China; (*h*) the accessibility of the Chinese coast and of the interior, and the development of transportation.

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